United States Court of Appeals
for the
District of Columbia Circuit

TRANSCRIPT OF RECORD

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BRIEF AND APPENDIX FOR THE APPELLANT

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA CIRCUIT

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For the
District of Columbia Circuit
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No. 13, 902

DONALD H. JACOBS,
Appellant,

v.

ROBERT C. WATSON, COMMISSIONER OF PATENTS,
Appellee

ON APPEAL FROM THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

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The Jacobs Instrument Company
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EX 3-0625

STATEMENT OF QUESTIONS PRESENTED

ON PROCEDURE

D1. The question is whether an adequate defense against a suit to obtain a patent under U.S.C. 35, Section 145, is presented by mere unsworn comments of defense counsel on the disclosure made by the references cited in the Patent Office, ignoring the fact that this is not a routine appeal from the decision of the Patent Office Board of Appeals, but a suit de novo against the Commissioner of Patents.

D2. The question is whether the defense, in a suit to obtain a patent under U.S.C. 35, Section 145, may introduce new grounds of anticipation of the invention with no advance notice thereof to the plaintiff.

ON THE QUESTION OF PATENTABILITY

The question is whether appellant's claims were properly rejected on the patent to Shanklin 2, 144,203 or the patent to Holmes 2,198,113, each in view of the patent to Strobel 2,248,727.

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UNITED STATES COURT OF APPEALS
For The District Of Columbia Circuit

No. 13,902

DONALD H. JACOBS,

Appellant,

v.

ROBERT C. WATSON, COMMISSIONER OF PATENTS,

Appellee

ON APPEAL FROM THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

BRIEF FOR APPELLANT

A. STATEMENT OF THE CASE

This is an appeal from an order of the U. S. District Court for the District of Columbia which denied a prayer under U.S.C. Title 35, Section 145 for a patent on an electronic navigation and position-finding system. Plaintiff's application for a patent on this invention was rejected by the U. S. Patent Office. Complaint was filed in the said District Court on 10 May 1955 (Plaintiff's Appendix, p. 34). The Court decided for defendant and dismissed the complaint on 6 March 1957 (Plaintiff's Appendix, p. 40).

The case presents a twofold issue: one on procedure, on the conduct of the trial; and one on the question of anticipation in fact of the claimed invention.

B. HISTORY OF THE APPLICATION

An application for a patent on the invention at issue was filed on 18 November 1948 (No. 60,731). During the prosecution of this application the Examiner stated that the invention was patentable and agreed to allow a number of claims, provided certain additional claims were withdrawn. The appellant thereupon withdrew the claims to which the Examiner objected. Then the Examiner took the position that he would not allow the claims which he had previously agreed to allow.

A final rejection of the claims on the patents to Nosker or Holmes in view of Strobel was entered on 17 August 1951. On 8 February 1952 appeal was taken to the Patent Office Board of Appeals. Then in his Statement of 23 April 1952, in answer to plaintiff's brief, the Examiner introduced a new reference, the patent to Shanklin, to bolster up the patent to Holmes.

The claims in issue are 33, 37, and 60-64. On 30 November 1954 the Board of Appeals reversed the rejection on Nosker in view of Strobel but rejected Claims 33 and 37 on Shanklin in view of Strobel and sustained the rejection of Claims 60-64 on Holmes in view of Strobel.

Upon request for reconsideration the Board of Appeals repeated its rejection on the same grounds on 25 April 1955.

Thereupon suit against the defendant, Commissioner of Patents, under 35 U.S.C. 145 to obtain a patent on the invention was brought on 10 May 1955. The trial was held on 6 and 7 February 1957. Plaintiff put on his case in the form of argument and sworn testimony. Defendant presented no witnesses; offered no sworn testimony; but relied merely on unsworn statements of counsel concerning the references cited by the Patent Office. Also defendant relied heavily on new figures of the Holmes patent, showing a device remarkably different from those of the figures relied on by the tribunals of the Patent Office while the case was pending in that office.

On the day after the trial the plaintiff prepared a Motion asking for either the case to be reopened or a new trial to be granted. The motion was dismissed on 15 February 1957 without a hearing. The defendant submitted proposed Findings of Fact and Conclusions of Law to the District Court and the plaintiff submitted a memorandum demonstrating that the Findings and Conclusions were inconsistent with the evidence. The Court refused to read the plaintiff's memorandum, and dismissed the action forthwith, on 6 March 1957. Notice of appeal by plaintiff was filed on 22 April 1957. The jurisdiction of the Court is invoked under 28 U.S.C. 1291.

C. QUESTIONS OF PROCEDURE

1. Is a suit to obtain a patent under 35 U.S.C. 145 nothing but a review of the decision of the Patent Office?

2. May the defendant Commissioner under 35 U.S.C. 145 rely on matter not previously referred to by the Patent Office where no advance notice of this shift of ground is given and no opportunity for due consideration and rebuttal of this new ground of rejection is afforded the plaintiff applicant for a patent?

D. ARGUMENT

D1. Nature of Suit under 35 U.S.C. 145

A suit brought under 35 U.S.C. 145 is not an appeal from the decision of the Patent Office Board of Appeals or a mere review of their decision.

This statute provides for a trial de novo. Such has always been appellant's understanding, so he presented his case in the form of sworn testimony, subject to cross examination. Furthermore, he also had in court two other professional scientists whose testimony he was prepared to offer, but when he arose to ask that they be heard, he was waved down by the court, so the case was rushed to termination without his being able to get them on the stand.

On the other hand the defense presented no witnesses and no sworn testimony, but acted on the assumption that a suit under 35 U.S.C. 145 is a mere review of the decision of the Patent Office Board of Appeals. The defense did not put in a single word of sworn testimony. The defense showing consisted only of various unsworn allegations of the defense counsel who was not under oath and was subject to no penalties if his statements were unfounded in fact. The statement of defense counsel that there is no invention in taking an idea from one patent and embodying it in another system of a totally different kind is a mere personal opinion, unsupported by any tangible evidence. Even though this allegation of the defense was adopted by the court with disastrous results to appellant's case, it is strongly urged that this over-simplified summation of the issue is neither accurate nor true. Appellant has done far more than simply taking an idea from one patent and embodying it in another. In contrast, he has devised and constructed and clearly disclosed in his application new and improved mechanism not shown in any reference for effectuating his invention and under 35 U.S.C. 112 (third paragraph) the appealed claims "cover the corresponding structure, material, or acts described in the specification and equivalents thereof".

The fallacy underlying the position of the defense will be established later in the brief. For the present it is desired to emphasize that the procedure followed by the trial court does violence to the theory that a suit under 35 U.S.C. 145 is a trial de novo on the merits and that to accept the unsworn allegations of defense counsel with no tangible evidence in their support (no corroborating testimony) is an avoidance of the correct theory that under 35 U.S.C. 145 the trial court is bound to weigh the evidence on each side carefully and to pay no undue deference to the decision of the Board of Appeals, which, because it is composed of Patent Office men, steeped in the traditions of Patent Office procedure, always, in the majority of cases, affirms the action of the Examiner.

D2. May the Defense under 35 U.S.C. 145 introduce new grounds of alleged anticipation with no advance warning to Plaintiff?

A new line of attack on appellant's request for a patent was taken by the defense at the trial; no new trial was granted, although request was made for same.

The patent to Holmes, 2,198,113, was one of the references principally relied on by the Patent Office. Holmes shows a number of separate and distinct inventions but the invention disclosed in his Figs. 8 and 9 had never been mentioned in any Patent Office action.

Then at the trial (p. 48, lines 2-4 of the transcript) defense counsel stated that on "p. 6, col. 1, line 36, the inventor Holmes refers to 'automatically and continuously' receiving indications". This is a reference to Figs. 8 and 9, the only figures concerning which the quoted statement could be made.

Appellant was taken by surprise by this action of the defense in relying upon a separate invention, shown only in Figs. 8 and 9 of the Holmes patent, which was entirely different from the structures shown in the figures relied upon during the prosecution of the case in the Patent Office, and which by all rights could have been made the subject of a separate patent.

This Holmes patent was so lightly regarded in the first office action that it was not used as a ground of rejection at all, but was only cited as being of interest. In the second office action it was used as a ground of rejection; then it was dropped entirely in the third action, which was the Final Rejection in which all substantial grounds of rejection are supposed to be listed. However, when new claims were submitted after the final rejection, the Examiner held them unpatentable over Holmes in view of Strobel. Then the decision of the Board of Appeals emphasized Holmes as an outstanding reference, dropping other grounds of rejection relied on by the Examiner.

Yet, in all this varied non-reliance, reliance, non-reliance and reliance on the Holmes patent, there was never at any time any attempt to use the structure of his Figs. 8 and 9 against any of the claims; no slightest hint or suggestion that these figures met any claims. The Board of Appeals in its lengthy decision discusses Figs. 1, 2, 4, 5, and 6, but dismisses Figs. 8 and 9 as having no bearing on the case. It is submitted that appellant had a right to assume that these Figs. 8 and 9 had as little pertinence to the issues here involved as the Examiner and the Board of Appeals had assigned to these figures.

Defendant's counsel, as a member of the Patent Office staff, is undoubtedly aware of the invariable rule imposed on the Office by statute (35 U.S.C. 132) that any rejection upon a new ground always gives the applicant a right to present argument and ask for reconsideration of the rightful effect of this new ground or alleged anticipation of his invention. Yet here, in a suit against the Commissioner under 35 U.S.C. 145, counsel raised a new ground of rejection against the invention with no advance warning of this shift of ground and with scant opportunity for due consideration and argument there-against by appellant. Furthermore, no testimony concerning this particular invention of Holmes was presented at the trial and it was not even described to the Court.

It is of no avail for defense counsel to say appellant should have been familiar with this widely variant invention of Holmes. Does the defense think appellant is a mind reader who can tell in advance just what unexpected line of attack on his claims will be presented when the case comes to trial? It is appellant's contention that these Figs. 8 and 9 of Holmes, so incidentally and inferentially brought into the record by the defense, were not properly before the trial court.

The inadequacy of this new device of Holmes as an anticipation of the invention here in issue will be demonstrated later. For the present appellant desires only to point out that here was a complete shifting of ground by the defense. Here was a new and unexpected ground of anticipation presented by the defense.

Appellant has no objection to the citation of new references which are pertinent. He does maintain that they should be introduced in a reasonable manner and that he should be given adequate opportunity to analyze them and reply to them.

The appellant filed a motion for a new trial or reopening of the case and in his "Memorandum for Plaintiff on his Motion for a New Trial or Reopening of the Case" (p. 3 of the memorandum, lines 2-9) he called attention to the fact that this reference to Figs. 8 and 9 of Holmes represented new material not previously referred to by the Patent Office. This motion was denied without a hearing.

If this is not sufficient cause for remanding the case to the District Court for a new trial, it should at least give this honorable appellate court occasion to stop and weigh the facts with great care before rendering a decision.

E. STATEMENT OF APPELLANT'S INVENTION

On 18 November 1948, Donald H. Jacobs filed an application (No. 60,731) for a patent on an electronic navigation and position-finding system in the U.S. Patent Office. This system is called JAINCO (after JAcobs INstrument COmpany), and it has the very important advantages over the prior art of greater accuracy, greater simplicity, and it requires no operator as it is completely automatic. It involves the location of the position of a vehicle (operating on sea, land, or air) relative to the positions of a group (normally, three) of fixed ground-based reference stations. One set of ground stations can be used for the navigation of an infinite number of vehicles. The moving vehicles (aircraft will be considered as a representative type herein) emit no radio waves while navigating with this system, and hence cannot be detected by a possible enemy intercepting such radiation. The system gives complete, continuous, and accurate position and navigating information to the aircraft's pilot while the system is in use. No reference cited by the Patent Office (see Def. Ex. 1-F, 1-G, 1-H), nor any combination of these references, possesses these attributes.

The JAINCO system, which is the heart of the Bomb Director System Mark 6 of the U. S. Navy (which was conceived and developed by the appellant), will be briefly described in its application to aircraft. The system uses three fixed ground stations: a master station and two slave stations. The master station and one slave station form a pair which gives one coordinate of aircraft position; the master and the other slave station form another such pair. The operation of one such pair will be considered here. Each of the two stations of this pair (one master, one slave) emits a continuous train of radio waves (sine waves). The two stations are synchronized by a separate radio link which keeps the two transmitted wave trains in phase, i.e., the waves emitted by the two stations have their peaks and troughs generated simultaneously. The two waves are received in an aircraft by two receivers, each tuned to one of the ground stations (This is accomplished by having the two continuous waves appear as modulations on two different carrier waves, one transmitted by each ground station.). If the airplane is equidistant from the two ground stations, the two waves will be received at the airplane in phase, that is, the crests and troughs of the two waves will be received simultaneously. If the airplane is not equidistant from the ground stations, the two waves will not be in phase when they reach the airplane, for they will have travelled different distances from the ground stations. The phase difference is a measure of this distance-difference. There are a number of points in space where the same given phase difference will be detected. These points all lie on a single curved line. Hence if the phase difference is known in the airplane, the airplane is known to be someplace on this line. Another such line can be determined by measuring the phase difference of the signals received at the airplane from the master ground station and the other slave station. The airplane will then be known to be at the intersection of these two lines.

For this system to be a useful navigational aid, it must be possible to make the phase comparisons in the airplane with very high accuracy (about one part in a million); yet the phase comparison equipment must be constructed with standard commercial components (which have accuracies of about 1 part in 10 to about 1 part in 100). In addition the phase comparison equipment must function continuously and automatically, and the phase comparison information must be presented to the pilot in a simple form so that it can be utilized for the navigation of an aircraft in a simple fashion. Any system utilizing a manual system of phase comparison is obviously useless in view of the speed of modern aircraft, and in view of the fact that in a fighter plane the pilot has no time to adjust navigation equipment. The JAINCO system satisfies all these objectives, and the specific means by which it obtains these results are part of the invention.

The means by which high accuracy is obtained with conventional electronic components of low accuracy will be considered first. It is evident that the waves whose phases are being compared must be of relatively long length. If they are very short, the phase comparison could be ambiguous, that is, there could be several waves from the slave station with which the wave from the master station could be compared. Hence this phase comparison would define several lines in space on which the airplane could be located, instead of only one. This difficulty can be eliminated by using a sufficiently long wavelength. However, using practical components, a phase comparison can be made accurate only to a certain percentage. Thus there are advantages to both short and long wavelengths, for the shorter wavelengths give much higher accuracy than the longer ones. In the JAINCO system, the longest wavelength is made sufficiently long to give an unambiguous reading of position; the next shorter wavelength is selected so as to give much higher accuracy but is made sufficiently long that any ambiguity will be resolved by the longer wavelength. In a typical case, the wavelengths are related in a 10 to 1 ratio. To get additional accuracy (without being troubled by ambiguity), additional shorter wavelengths are used. In a representative case, five wavelengths in all are employed, each wavelength being 1/10th that of the next higher one. The position coordinate is read from the five phase comparisons, each comparison contributing one digit to the final result. Thus the position is read from these phase comparisons in the same fashion as distance is read on the mileage indicator in an automobile.

The various wavelengths are transmitted simultaneously, and are received simultaneously in the airplane. There they are separated from each other by filters, and separate phase comparisons are made automatically at each wavelength, that is, at each wavelength the signal from the master station and the signal from the appropriate slave station are compared as to phase.

The phase comparisons are made by a continuous, automatic, and instantaneous means which is a part of this invention. The basic device used for phase comparison is a cathode ray tube: a very minute version of the type of tube employed as the picture tube in television sets. A single wavelength from the master station is imposed, via an electrical network (phase splitting) to one pair of adjacent deflection plates in the cathode ray tube; the equivalent signal from one of the slave stations similarly is applied to the other pair of adjacent deflection plates. The result is a straight line which appears across the face of the tube, along its major diameter. The angular position of this line, relative to a fixed diametral line, is a measure of the phase difference of the two waves. This line is used as a pointer, and in a typical case, points to one of ten digits marked around the circumference of the tube. Hence the digit indicated by this tube is one digit of a coordinate of position. Four additional similar phase comparators are used to give the remaining digits of this coordinate (which is established by the master station and one ground station); another group of five such phase comparators give the other coordinate which is established by the master station and the other slave station.

These phase comparators work continuously and automatically, and hence are usable in fighter aircraft. A typical method of operation involves the approach of an aircraft to a desired position (hereinafter called the "target") by approaching on the line of equal phase difference which passes through the target. The pilot can get on this line by determining the coordinate of the line from a map; then by flying the aircraft until this number appears on one set of indicators. He then turns and flies along the line, this being accomplished by turning the aircraft until the indication on one set of comparators remains fixed at the desired value. As long as he remains on this line to the target, the phase comparison indication on these indicators remains unchanged. The pilot need only watch the most sensitive indicator, i.e., that indicating the smallest digit in the coordinate, in order to stay on course. Thus one set of phase indicators keeps the aircraft on course. The other set indicates the distance to the target. When the number presented by this set reaches the value of the target coordinate, the plane will be over the target; when the number indicated by this set approaches the target coordinate the airplane will be known to be approaching the target. The position of the aircraft can be determined at any time by noting the two coordinates (one shown on each set of indicators) and by then referring to a map on which the equiphase lines have been printed. The location of the plane is at the intersection of the two lines whose numbers are shown on the phase comparators.

The fundamentals of the JAINCO system are as follows:

1. The system uses a plurality of ground stations: one master station and several slave stations.
2. Each ground station transmits a series of modulation wavelengths (related to each other by some such fraction as 1/10th); these modulations are transmitted on a carrier wave which is different in frequency for each ground station.

3. The modulation waves transmitted from the slave stations are synchronized in phase with those transmitted from the master station by radio links between the master station and the slave stations.
4. The carrier waves from the ground stations are each received by a different receiver in the aircraft. The modulation waves are removed from their respective carriers, and are separated from each other by filters.
5. The modulation waves are compared with each other with respect to phase continuously and automatically by a cathode-ray tube phase comparison device which acts as a combined phase comparator and phase difference indicator.

F. THE ISSUE OF PATENTABILITY; THE REFERENCES USED

Appellant's claims should not have been rejected on the references used against the same.

I. The Patent to Nosker, 2,470,787

The Nosker patent was used only once by the Examiner as a ground of rejection. This was in the final rejection and this rejection was specifically reversed by the Board of Appeals. It is easy to see why this patent was so lightly regarded by the highest authority in the Patent Office.

While Nosker may at first glance seem to show a system somewhat like appellant's, nevertheless it operates in quite a different fashion. In its preferred form it is not a navigation system to help a pilot keep on his course, but a means whereby a ground station is able to keep track of the changing distance from the station to a moving airplane.

Nosker uses a main ground station, S1, and two subsidiary ground stations, S2 and S3. Modulated radio signals are sent from S1 to the plane and from the plane they are retransmitted to S1, S2, and S3. The signals thus received at S2 and S3 are sent back to S1, and at S1 the differences in the phases of the modulation frequencies carried by the signals are determined. From these differences the location of the plane in space is established at the ground station.

Nosker does state that he can place station S1, with its transmitter, receivers, phase comparators, etc. on the plane, if desired. But the system based on the transmission and retransmission of the modulated signals is so radically different from appellant's that it is easily understood why the Board of Appeals would have nothing of Nosker. The trial court made no reference to Nosker and it is believed this honorable Court of Appeals will agree that Nosker offers no valid anticipation of the invention in issue.

II. The Patent to Shanklin, 2,144,203

Claims 33 and 37 were rejected by the Board of Appeals on a new reference, the patent to Shanklin in view of Strobel. This Shanklin patent had never been used by the Examiner as a ground for the rejection of any claim. It was introduced only in the last paper filed by the Examiner to bolster up the patent to Holmes.

Shanklin uses two pairs of spaced land stations, A, B, and C, D for transmitting signals carrying a plurality of modulation frequencies to a moving station.

At the moving station there are two receivers for receiving the modulated signals from two stations and these receivers are connected to a single phase comparator for comparing, in turn, the phases of each of the modulation frequencies as they reach the moving station. Shanklin has only one phase comparator, which he does not explain or describe, and this seems to be capable of comparing, in sequence (i.e.

by successive switching operations), the phase of three different modulation frequencies without any adjustment or alteration. It is highly unlikely that a comparator, working equally well at 150 up to 15,000 cycles without change or adjustment, was in existence at the date of Shanklin's patent or at the present time. But this is only one trouble with Shanklin as a reference.

To give accurate results the signals from the two transmitting stations must be synchronized in phase. Shanklin says he does this "by reference to any standard frequency or by land lines" (p. 1, col. 1, lines 39-40). Just what is meant by this "standard frequency" is not explained; so far as an adequate disclosure is concerned it means absolutely nothing. The use of land lines is unreliable and practically impossible under battle conditions, and even if there is nothing to disturb the land lines, it is difficult to maintain accurate synchronization by this means.

Appellant maintains synchronization of his modulation frequencies by transmitting them simultaneously by radio waves to the unknown point and to the other transmitting stations. This is a clear distinction of the appealed system over the reference.

Shanklin's control stations are fixed. Appellant's stations can be mounted on trucks, readily movable from place to place, since there is no fixed connection between them.

Shanklin describes only two receivers for his four sending stations. While he says he may have other receivers for C and D, he still must have four stations to do what appellant does with three stations; personnel at these four stations; land line or lines connecting them in pairs; an extra receiving means for station 4 at the unknown point; all to do what appellant does with only three stations, three transmitters, and five receivers, two of these receivers being substituted for Shanklin's cumbersome and expensive land lines. Appellant's system is simpler, more economical, more efficient, much more accurate and is instantaneous and automatic in action.

Shanklin has three filters for his three frequencies from each station to separate the frequencies from each other. He connects these filters to his single phase comparator by switches 18. He must shift these switches to compare his different modulation frequencies, one at a time. He does not and cannot compare them all simultaneously or automatically. Always he must intervene manually to shift these switches.

Shanklin's two other stations, C and D, are in like manner sending modulated signals. After he compares the signals from A and B, Shanklin must tune his receivers to stations C and D and compare the phase of the modulation frequencies from these stations; and again to compare the 150-15,000 cycles he must twice more shift his switches 18. Shanklin does not compare the modulation frequencies from any pair of stations simultaneously and automatically. Still less does he compare the signals from two different pairs of stations simultaneously and automatically.

To compare the phase of the signals at any one modulation frequency he must have his switches 18 set to that frequency. To compare any other frequency he must shift to place that other frequency in connection with the comparator. To compare the third frequency he must shift again, and for the other pair of stations he must go through this multiple switching all over again. With an unknown station which is moving at the speed of today's airplanes, Shanklin could not possibly shift back and forth between his different filters and his different stations and make his many phase comparisons quickly enough to give a reliable indication of position. Each comparison of each frequency would necessarily be made at a different distance from the stations. The whole assemblage of comparisons would be inaccurate and dangerously unreliable. Shanklin's system is of no use whatever for the airplanes of today.

III. The Patent to Strobel, 2,248,727

The new rejection made by the Board of Appeals was on Shanklin in view of Strobel. This latter patent shows only a distance-measuring system; not a navigation system. Modulated wave energy is transmitted from Station A to Station B and at Station B it is received and the modulation frequencies are retransmitted back to Station A. The distance between A and B is determined at Station A by comparing the phase of the retransmitted modulation frequencies with those originally transmitted from A to B.

Strobel uses a series of modulation frequencies and explains (p. 3, col. 1, lines 35-70) how a higher frequency gives greater precision in the measurement.

However, Strobel does not compare these frequencies simultaneously or automatically and his mechanism for phase comparison is very crude and fumbling, requiring constant manipulation and adjustment by the operator.

On p. 2, col. 2, lines 59-75, Strobel describes his phase comparison device and explains that phase shifter 31 must be manually adjusted "until the meter reading is zero". The dial of phase shifter 31 is read to determine the wave length and (top of col. 1, p. 3) when the frequency and wave length are known "the distance of separation of the stations may at once be computed". But he is a long time getting to that "at once" and even when he does he is only ready to start his computation. Even with all he can get from his cumbersome apparatus he must take additional time to make computations.

The Board of Appeals relied on Figs. 5 and 6 of Strobel. These figures are not fully described in the patent, but the phase comparison means of Fig. 6 is only a duplication and repetition of that shown in Fig. 3, so it must operate in the same way. As described in col. 2, p. 3, the two signals from the two stations must be adjusted to equal magnitudes by adjusting variable resistors 38, 39 (lines 4 and 5). But the system is most accurate for 1/4 of a wavelength. If the case examined involves only a small fraction of a wavelength, Strobel throws a reversing switch 44 (lines 32-36) "so that now the smaller distance may be measured precisely".

But still there are uncertainties and complications. If the meter reading is near zero, he has to shift the frequency fm and note its effect to determine whether the reading "corresponds to the point a or to the point b on the solid curve 50 of Fig. 4" (lines 37-48).

Remember, too, that all these complex manipulations must be multiplied threefold in Fig. 6 when he uses three modulation frequencies. There are six variable resistances; three reversing switches; three frequencies fm to be shifted; three meters to be watched all the time.

Strobel's patent was granted 16 years ago when airplane speeds were not so great as now. At present speeds by the time Strobel had finished his determination of phase shift for only one modulation frequency the plane would be many miles from where he began manipulating his resistances and switches and phase shifters. By the time he had made three such determinations the plane would be so far away from where he began that the determinations would be meaningless and valueless.

IV. The Patent to Holmes, 2,198,113

This patent shows a multiplicity of inventions, all within the folds of a single patent. Holmes does send modulated radio waves to an unknown station and compare the phase. But he does not meet the claims in issue.

In Fig. 1 Holmes transmits modulated signals from a plane in flight to a fixed station and retransmits them back to the plane. By comparing the phase of the modulation frequencies as transmitted and as received back at the plane he says he determines the distance between the two points.

In Fig. 2 Holmes has two fixed stations connected by a land line (i.e. by one or more wires) for furnishing to them modulation frequencies which are transmitted in phase to a plane in flight. On p. 4, col. 1, lines 60-64, Holmes also mentions transmitting the modulation frequencies from one fixed station to the other by radio waves. On the plane are two receivers and a phase comparator for determining the difference in phase between the signals received. Holmes says if the plane is moving from one station to the other the difference in phase will determine its distance from the two stations.

In Fig. 3, which was not mentioned in the decision of the Board of Appeals, Holmes provides two transmitters 21 and 24 sending modulated signals to a body moving between the transmitters. Modulation frequencies of 500 cycles per second are supplied to and radiated from 21; the same modulation frequencies are multiplied to 1,000 cycles and radiated from 22. On the moving body a receiver 26 receives these modulations, filters 27 and 28 separate the 500 cycles from the 1,000 cycles, multiplier 29 multiplies the 500 cycles to 1,000 and the two sets of modulations, both now at 1,000 cycles per second, are fed to and compared as to phase by the phase angle indicator 20. By this comparison the position of the body between the transmitters is determined.

In Figs 4 and 5 Holmes has four stations transmitting to a moving plane, much like Shanklin. However, Holmes' modulation frequencies are generated at one fixed station 35 and transmitted therefrom to the plane and to the second station 36. Signals from station 35 are likewise picked up by station 37 and transmitted therefrom to the plane and to station 38. The modulation frequencies received at 36 and 38 are retransmitted to the plane, with stations 35 and 36 in phase and stations 37 and 38 in phase. The variation of the phase of the signals from these pairs of stations is determined on the plane.

In Fig. 6 Holmes shows a modification of the schematic diagram of Fig. 5 in which only three reference stations, 35, 36, and 37 are used and these are grouped in pairs, 35, 36 and 35, 37.

Fig. 7 also uses four stations but spaces them differently; those of each pair quite close together, but each pair spaced quite a distance from the next pair.

This Holmes patent shows and hints at several different distance measuring and navigation systems. None of them utilizes a plurality of modulation frequencies to obtain an accurate determination of position, and none shows a phase comparing and phase indicating means similar to appellant's either in structure or results obtained. The systems which are clearly described (those of Figs. 1, 2, and 3) are different from appellant's. The closest thing Holmes has to appellant's system is his Fig. 6. However Fig. 6 shows only a map, and we have to guess at what equipment is used to obtain this map. Holmes indicates that this map is a three-station version of the equipment shown in Fig. 5. However Fig. 5 is also a map, and is obtained by using the equipment of Fig. 4. Fig. 4 shows a four-station version of the equipment shown in Fig. 3, and this system is completely different from appellant's for it uses a single receiver at the moving station to receive all ground stations (p. 5, col. 2, lines 71-72). Holmes also states that his Fig. 4 can be used with the techniques shown in Figs. 1 and 2, but this statement is clearly in error because the utilization of the techniques of Figs. 1 and 2 in a four-station system would require the moving station to have a plurality of receivers whereas the moving station of Fig. 4 expressly has only one receiver. Even if the techniques of Holmes' Fig. 2 could be projected into his Fig. 4 (which actually cannot be done), and Fig. 4 projected into Fig. 5, and Fig. 5 projected into Fig. 6, the result would still be a far cry from appellant's system because Holmes does not (and cannot) use a plurality of modulation frequencies to increase his accuracy, and utilizes a different phase comparison means.

To avoid ambiguity in the determination of position a modulation wave, greater in length than any possible distance difference involved, must be used. To secure accuracy in determining position within narrow limits, additional modulation waves successively shorter in length must be used. A single modulation wavelength, as used by Holmes, whether long or short, will not give a reliable indication of position.

In lines 32-35, col. 1, p. 3, Holmes speaks of using a cathode ray tube for a phase comparison device, but he connects it differently from appellant's. He connects the source of the modulation frequencies to one set of deflection plates and the received modulation frequencies to the other set. Connected like this, there will be a straight line across the face of the tube when the signals are in phase, and a circle when they are at 90° from each other. They will be in phase only at the starting point or at a point beyond the destination of the plane, so the straight line gives no indication of position. Between zero° and 90° the cathode ray tube will show ellipses of varying shape, each shape corresponding to a different phase. One cannot judge the shape of an ellipse by visual observation, and hence a phase comparison cannot be made by eye with this equipment. Hence this device cannot indicate distance or position with even a crude degree of accuracy. Holmes also gives himself the option of using for a phase angle indicator "any one of the various types" but appellant could not find any commercially available phase angle indicator capable of high accuracy and/or fast indication in rapidly moving planes. He had to invent his own.

Holmes' description of his Figs. 4 and 5 is confusing. In col. 2, p. 5, he says the same modulation frequency from a common source is used to modulate the carrier wave transmitted from each pair of stations and then the carrier waves themselves are different (lines 46-52). His receiving equipment includes only a single receiver, "which is capable of receiving the modulated carrier waves from either pair of stations" (lines 72-74) and also "includes a phase angle indicator" (line 75) to indicate the difference in phase. That is, a single receiver will receive two different carrier waves from two different stations at the same time.

This is impossible. A receiver may usually be adjusted to receive different stations at different times. But it cannot be built to receive two different stations on two different wavelengths at one and the same time.

On p. 5, col. 2, lines 30-34, Holmes says the stations of Fig. 5 may be operated in accordance with the examples of Figs. 1, 2, or 3. If this reference is expanded to include in the stations the equipment of Fig. 3, doubling the frequency sent from one transmitting station before transmission and doubling the frequency received from the other station after its reception, as in Fig. 3, such a system could work with "a receiver" as it was operated in Fig. 3. This may possibly be the meaning of his statement that the waves radiated from one pair of stations may be the same and the modulation frequency supplied to one station of a pair will be different from that supplied to the other station of the pair (p. 5, col. 2, lines 52-59). It should be pointed out, however, that the Patent Office did not so understand it, but when objection was made that this structure was impossible, the Examiner brought in the reference Shanklin to prove that "a receiver" means two receivers.

On p. 6, col. 1, lines 4-33, Holmes says his "receiving equipment 41 is tuned to receive from stations 35 and 36" (lines 9-10) and then if "the equipment 41 is now tuned to receive from stations 37 and 38" (lines 15-16). Thus his receiver must be manually tuned to one pair of stations or the other. Apparently the reference in lines 26-34 to "substantially simultaneously from both pairs of stations" contemplates rapidly switching this tuning means back and forth from one pair of stations to the other so that the indications are "substantially simultaneously" produced (emphasis added) (line 28). There is no provision of means for truly simultaneous indication of different values from different pairs of stations. The "simultaneously producing two sets of indications" of lines 30-31, is qualified by the "substantially simultaneously" of line 28. But substantially simultaneous is not simultaneous.

In his description of Fig. 6 Holmes introduces another confusing feature. He says (col. 1, p. 6, lines 46-51) that he compares the phase difference of the signals from stations 35 and 36 with the phase difference of the signals from 35 and 37. Here is an absolutely new idea, never mentioned or hinted at in any other publication known to appellant. It is known to compare the phase of the signals received from two stations. But what is gained from comparing the phase difference between two stations with the phase difference between another pair of stations? What does he learn from it? Echo answers "What?" Holmes offers no explanation. Appellant can think of none.

As pointed out under Item D2, above, this Holmes patent had a checkered career before the Patent Office, being first not used as a ground of rejection, then used, then not used and then again used. The handling of the patent by defense counsel at the trial is also interesting and unusual.

When the Court asked what art was relied on, defense counsel stated: "The two most important references are Holmes, particularly Fig. 4 and 5 and Strobel" (p. 23, Transcript, lines 2-4).

But when appellant stated "the Patent Office has primarily relied on Fig. 4 of Holmes" (p. 37, Transcript, line 10), defense counsel objected "Your Honor, I object to this point on this matter. The witness has stated that the Office has relied primarily on Fig. 4. He is speaking under oath, and I would just like to call attention to the fact that the Patent Office has relied on . . . " (same page, lines 13-17). But at this point he was stopped by the Judge.

Then on p. 46, Transcript, line 6, defense counsel stated the "Office relies on Fig. 6" and in line 13, same page he refers to Figs. 4 and 5; while on p. 48, lines 2-4, he states that "at p. 6, col. 1, line 36, the inventor Holmes refers to automatically and continuously receiving indications" and this was done with no hint nor warning to the court nor to the plaintiff that he was bringing in the new and different invention shown by Holmes in Figs. 8 and 9, matter not previously discussed nor referred to in any Office action, since the Patent Office relied on Figs. 4-6 of Holmes while the application was pending before it. The paragraph on p. 6, col. 1, lines 34-39 is quoted here:

> "It is also within the contemplation of this invention to provide means for combining these two coordinates to automatically and continuously indicate the location of the airplane on a map or other means carried thereby, as will be described hereinafter."

The device referred to here is the mechanism shown in Figs. 8 and 9, the only mechanism disclosed by Holmes in which any attempt at automatic indication is made. These figures, while theoretically possible, seem utterly fantastic, and it is very doubtful whether such a structure was ever actually made and put to use.

In Figs. 8 and 9 Holmes mounts a translucent map in the plane with a reflector beneath it to project up to the map a spot of light which moves as the plane moves and is supposed to show the pilot of the plane just where he is. The reflector is mounted to swing on two axes at right angles to each other, the rotation about one axis being controlled by the phase differences between one pair of stations to move this spot of light beneath the map, and the rotation about the other axis being controlled by the phase difference between another pair of stations.

While ingenious in theory, such a structure is obviously of little practical value. It is one of those things that an impractical inventor dreams up. Every time he flies over a different terrain the pilot must mount above this reflector a different map, properly positioned and oriented. This idea is tied to the short airplane flights of the time when Holmes dreamed up the idea, some 20 years ago. For a non-stop flight half-way across the continent, or beyond, a large number of maps would be required, and each map would be on such a small scale as to be practically useless.

Holmes does say (p. 7, col. 1, lines 64-66) that the axis on which his reflector is mounted may carry a pointer, but does not explain what kind of fixed reference scale he can mount back of a pointer which is, in effect, mounted on a universal joint, freely swingable in any direction.

Holmes also states (p. 7, col. 2, lines 43-46) that his translucent screen may be provided with scale markings, but it still could not indicate phase differences, but only the resultant of two separate phase differences.

Thus the Holmes patent suffers from impractical and inoperative ideas and a vague and confusing description. But its greatest defect is that it uses only a single modulation frequency and cannot give an accurate and reliable indication of position.

Furthermore, for his device of Figs. 8 and 9, Holmes must obviously have his stations on lines at right angles to each other. These stations are normally placed on hills to secure good transmission and reception conditions, and it is difficult to find three or four hills so positioned that lines joining them are at right angles to each other.

G. ERRORS OF THE TRIAL COURT

The Court's Fourth Finding of Fact reads as follows:

> "4. The patent to Holmes No. 2,198,113 discloses a method of determining the position of an unknown station by phase comparison of modulation frequencies and of navigating by hyperbolic iso-phase-difference curves, the apparatus for which includes a system of three reference stations, each transmitting a carrier wave different from that of the others,

> but having impressed thereon a common modulation frequency supplied from a source at one of the stations. The unknown station is disclosed as including apparatus simultaneously and separately to receive the modulation frequencies from any pair of the reference stations and simultaneously and automatically to indicate the phase difference for each pair."

In this Finding the court erred in holding in the last sentence that the Holmes patent has "apparatus simultaneously and separately to receive the modulation frequencies from any pair of reference stations and simultaneously and automatically to indicate the phase difference for each pair".

Holmes discloses numerous distinct and separate inventions. No indication is given in the finding which of these different inventions is believed to make the indication mentioned.

The reference in the first sentence of the finding to three reference stations will eliminate Holmes' Figs. 1-3. This same reference to three stations might lead one to look first at Fig. 6, but this figure shows only a map with no apparatus and it fails to meet the quotation because it gives no indication whatever of the "phase difference for each pair of stations". The phase difference is compared, but Holmes doesn't speak of providing any indication of same. Instead "the phase difference of the modulation frequency of any one pair of stations, for example, the stations 35 and 37, may be compared with the phase difference of the modulations received from the other pair of stations . . . . 35 and 36" (p. 6, col. 1, lines 45-51).

Holmes shows no means for making such a comparison of comparisons and offers no reason for it, another example of the vagueness of a patent granted by the Patent Office. Obviously Fig. 6 does not "simultaneously and automatically" "indicate the phase difference for each pair".

Fig. 4 has four reference stations, so it could be said to have three. However Fig. 4 doesn't compare three stations; it compares four stations in pairs. It has only a single receiver, as pointed out above, for these four stations, and only a single phase comparator (lines 70-75, col. 2, p. 5). Just how this single receiver can "separately receive the modulations from any pair" of stations is not described by Holmes, nor by the court. Did the defense in preparing this finding mean that the phase difference of the separate stations could be determined at separate times? It seems this would be necessary, since the figure has only one phase comparator, as pointed out above, but such a mode of operation is far astray from the implied intent of the finding and also from the showing of appellant's invention.

Fig. 5 is only a schematic map.

Figs. 4 and 5 do not meet the finding, nor anticipate appellant's claims.

Fig. 7 shows four stations schematically, in this respect like Fig. 4, but the four stations are located differently. Again, they use only a single phase comparator and use it successively, first on one pair of stations and then on the other (lines 45-49, col. 2, p. 6). Holmes' Figs. 8 and 9 use four stations, as in Fig. 4, and do compare the phase, but the only indication is in simulated position on a map, a composite of the two phase differences, but no actual indication of any single phase difference at all. Furthermore, unless the distance travelled is rather short, so the map can be on a sufficiently large scale, the indication of position will be only rudimentary and schematic, and not reliable in showing actual position.

It is contended that, in fact, Holmes has no showing of means to "simultaneously and automatically indicate the phase difference for each pair" of stations, and that the holding in this fourth finding is error by the trial court.

The Court's Fifth Finding of Fact reads as follows:

> "5. The patent to Strobel No. 2,248,727 discloses the concept of and the apparatus for increasing precision of distance measurements by phase comparison of modulation fre-

> quencies wherein the same series of different modulation frequencies is simultaneously impressed on each of the different carrier waves for two stations and continuous and simultaneous phase comparison is made for each modulation frequency with respect to the two stations."

The Fifth Finding of Fact is error by the trial court in that Strobel definitely fails to make and could not possibly make the "continuous and simultaneous phase comparison" " for each modulation frequency" as alleged in this finding. It has been pointed out above in the discussion of the Strobel patent that he requires and clearly admits the necessity for a great number of manual adjustments of his apparatus for each phase comparison, and at each modulation frequency. Appellant is unable to understand how anyone could say that Strobel makes continuous and simultaneous phase comparisons.

Note the description in col. 2, p. 3 of Strobel. First you must adjust variable resistors 38 and 39 (lines 4 and 5); then throw reversing switch 44 (lines 32-36); then shift the frequency fm and note its effect (lines 37-43). This must be done at each modulation frequency. How can anyone say that with all this manipulation Strobel can make continuous and simultaneous phase comparison?

This finding is definite error by the trial court.

The Court's Sixth Finding of Fact reads as follows:

> "6. None of the plaintiff's application claims 33, 37, and 60 to 64 are limited to individual phase difference indicators having either a degree of accuracy or a degree of automatism distinguishable from Strobel's indicators used without manipulation of the reversing switches or distinguishable from Holmes' described automatic indicator."

The Sixth Finding of Fact is in error in stating that none of appellant's claims call for a "degree of automatism distinguishable from Strobel's indicators used without manipulation of the reversing switches or distinguishable from Holmes' described automatic indicator".

There is no good foundation for such a statement. Elimination of Strobel's reversing switches could not by any stretch of the imagination render Strobel's system automatic in action. Strobel would still have to adjust phase shifter 31, watching the meter until it registers zero (p. 2, col. 2, lines 68, 69); then adjust resistors 38, 39 to bring the signals from the two stations to equal magnitudes (p. 3, col. 2, lines 4 and 5); and also shift the frequency fm and note from the effect of this maneuver whether the reading "corresponds to the point a or to the point b on the solid curve 50 of Fig. 4" (p. 3, col. 2, lines 39, 40).

Strobel would have to eliminate far more than his reversing switches to make his device automatic. If he eliminated all of these adjusting devices, his apparatus would have no accuracy whatever. Also, and most convincingly, he makes no disclosure at all of any mechanism which could function in any way without these adjustments.

Appellant's Claims 33, 37, 62, and 64 specify automatically comparing the phase or automatically indicating the difference in phase. It would be a misnomer to call Strobel's device automatic. He makes no such claim. His mechanism must be constantly adjusted in use and he admits it even to the point of putting "adjusting" in almost all of his claims.

Holmes in his Figs. 4-7 cannot automatically compare the differences in phase, since he must shift his comparator from one pair of stations to the other. Conceding that in Figs. 8 and 9, now at long last relied on (at least in argument, if not in testimony) by the Patent Office, Holmes does purport to show an automatic indication of position on a map very small in scale, it must be pointed out that his apparatus relies on only a single modulation frequency and hence is not reliable for indicating the actual position of the airplane, for the reasons above pointed out. These Figs. 8 and 9 disclose means for moving a spot of light over the map, indicating the resultant of the differences in phase of a single modulation frequency as transmitted to the observation point from two pairs of stations.

Holmes has no inkling of Strobel's plural modulation frequencies. Holmes never used a series of frequencies. Holmes offers no suggestion of any way to adapt this last or any species of his invention to the plural modulation frequencies disclosed by Strobel. Neither has the defense indicated how its glibly proposed modification and hybridization of these two widely variant inventions may be effectuated in fact.

The patent statutes in 35 U.S.C. 112 provide that "an element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof".

Under this paragraph appellant's recital of means for automatically comparing the phase of the various modulation frequencies, or for automatically indicating the phase difference for each modulation frequency imparts into the claims the highly efficient and accurate mechanism devised and described by appellant for this purpose.

Obviously, it is impossible to put the entire specification into a claim. By the paragraph quoted the patent code embodies in the claims the apparatus which appellant has invented and disclosed for automatically and accurately determining and indicating the difference in phase, in effect limiting the claims to the particular mechanism devised by appellant and reasonable equivalents thereof.

For these reasons the Sixth Finding of Fact is error by the trial court.

The Court's Seventh Finding of Fact reads as follows:

> "7. The patent to Shanklin No. 2,144,203 describes at least two reference stations A and B transmitting different carrier waves, means for impressing a plurality of synchronized modulation frequencies on each carrier wave, and means on a movable station for successively comparing the phase of each modulation frequency as received from a pair of reference stations."

The Seventh Finding of Fact admits that Shanklin must compare the phase of his different modulation frequencies successively. This is done by shifting his switches 18. Appellant admits this is true. But there is nothing simultaneous or automatic about it and nothing to anticipate appellant's claims. It may be added that the opinion of the court did not mention Shanklin at all. The court's opinion held only that the claims are not patentable over Holmes in view of Strobel.

The Court's Eighth Finding of Fact reads as follows:

> "8. No error is found in the holding of the Board of Appeals in its decision on reconsideration that, with respect to Fig. 7 of the Jacobs application, it could not be determined "from these diagrams or the cryptic description of these members in the instant specification how many manual switching and adjusting operations are necessary to make phase comparisons."

The Eighth Finding of Fact adopts and endorses the error of the Board of Appeals in the holding quoted from lines 16-19, p. 3 of the Board's decision on appellant's request for reconsideration. While the drawings are admittedly schematic, that is often the best and clearest way to show the invention. There is nothing cryptic about them or the description. No adjustments of the apparatus are necessary. The specification clearly states that the device operates to show the angle of phase difference by using a straight line across the face of each of the small oscilloscope tubes as a pointer. No objection as to the clearness of disclosure was raised at any time during the years the application was prosecuted until the last page of the last action by the

Patent Office. It is urged that this objection is clearly unwarranted and also is raised too late, and that the Court's endorsement of this holding was error by the trial court.

The Court's Ninth Finding of Fact reads as follows:

> "9. No patentable invention is involved in increasing the precision of the system of Holmes by substituting for his use of a single frequency modulation Strobel's multiple frequency modulation system with simultaneous and continuous indication."

The Ninth Finding of Fact alleges no invention in increasing the precision of Holmes' system by substituting for his single frequency modulation Strobel's multiple frequency modulation system "with simulteneous and continuous indication". These last quoted words seem rather cryptic; do they mean Strobel has this kind of indication? Or do they mean no invention in substituting in Holmes the multiple frequency modulations of Strobel, with simultaneous and continuous indication added to Strobel in some fashion undisclosed?

In either event this Finding is error by the court. Strobel has no simultaneous and continuous indication, as has been clearly pointed out. All of Strobel's indications must be worked out separately and difficultly for each modulation frequency. His mechanism is laborious and time-consuming in use. To say that he has "simultaneous and continuous indication" should be held to be reversible error. When Strobel makes one determination he can only hold it in his memory while he works out the next determination. He has no concept of continuous indication of any value he obtains.

On the other hand, if the finding contemplates adding this "simultaneous and continous indication" to the hybrid Holmes-Strobel reference from some other source, not indicated, this, too, is error. The source should be identified.

"Simultaneous and continuous indication" of phase differences of a plurality of modulation frequencies is true only of appellant's invention, not of any reference. There is no suggestion in any reference of a "simultaneous and continuous indication" of the phase difference of a plurality of modulation frequencies received from even a single pair of control stations.

This Ninth Finding is error by the court.

The Court's Tenth Finding of Fact reads as follows:

> "10. Claims 33, 37, and 60 through 64 do not define patentable invention over Holmes in view of Strobel."

The Tenth Finding, that the claims are unpatentable over Holmes in view of Strobel, assumes that Holmes shows the same system as appellant's, except for the multiple modulation frequencies which are imported from Strobel. In actuality Holmes' system is not the same as appellant's and, as pointed out above, Holmes' description of what he does show is vague and confusing in parts. Figs. 8 and 9, which the defense has injected into the case of surprise, at the last moment, purport to show position on a map by data obtained from the use of only a single modulation frequency. They clearly do not show any phase differences obtained from the use of a connected series of modulation frequencies. All that they can show, schematically and vaguely, is the resultant of two differences of a single frequency.

Strobel's indications of phase difference, so laboriously obtained, must be worked out separately and individually for each modulation frequency. There is nothing simultaneous or continuous or automatic about this determination by Strobel.

The patent to Strobel suggests using three different modulation frequencies. Appellant's specification discloses the use of five such frequencies. How can Holmes in Figs. 8 and 9, now relied on by the defense, be combined with Strobel to incorporate these different frequencies? Is he going to use three or five maps, each on a different scale, with separate phase comparison means for the separate modulation frequencies connected to these separate maps? Or is he going to use three or five sets of phase comparison mechanisms all connected to the one reflector for moving the spot of light across the map by some form of universal joint which would provide a mechanism complicated to the nth degree? Actually Strobel and Holmes' Figs. 8 and 9 are incompatible. They cannot be combined without recourse to the highest kind of inventive creativity, and even if they were combined, they would not show individual phase differences, but only the resultants of cooperating differences.

Finding 10 is error by the Court.

The Court's Eleventh Finding of Fact reads as follows:

> "11. No error is found in the holding of the Board of Appeals that claims 33 and 37 do not define invention over Shanklin in view of Strobel."

The Eleventh Finding adopts and endorses the erroneous opinion of the Board of Appeals that Claims 33 and 37 are not patentable over Shanklin in view of Strobel. There was no good reason for the Board to use Strobel in this connection. From the last few lines on p. 12 of the decision of the Board it appears that they included Strobel in the rejection because he uses the word "simultaneous" in p. 3, col. 2, line 72, while Shanklin admittedly makes his phase comparisons successively. However, in actual fact there is no simultaneous comparison of the frequencies in Strobel.

Note Strobel's description of his apparatus in col. 2, p. 3. The operator must first adjust the variable resistors 38, 39; then the reversing switch 44; then shift the frequency fm. All this must be done in succession for each frequency. It could not possibly be done simultaneously for even two frequencies.

Shanklin is not a reference for the claims because he compares his modulation frequencies one at a time, successively, by shifting his switches 18. Also Shanklin connects his stations by land lines, while the instant claims call for transmitting signals between the stations by radio waves. Also, there is nothing automatic about Shanklin's or Strobel's determination of phase difference. Furthermore, as pointed out in connection with Finding 7, Shanklin is not mentioned in the opinion of the court.

Finding 11 is error by the court.

The Court's Twelfth Finding of Fact reads as follows:

> "12. Claims 33, 37, 60 through 64 do not define patentable invention over the prior art."

Finding 12 is by its generality too vague to be sustained. Rule 106 of the Patent Office requires the Examiner to cite the best references at his command. The Office has said the present claims offer no invention over the references above analyzed. All of these references have been definitely overcome. The claims here presented are clearly patentable over each and every reference and over any possible comination thereof, for the good and sufficient reasons above stated. If there is any other stronger art, it is incumbent upon the Patent Office to cite it. It is impossible for the appellant to controvert an objection not clearly specified. Neither would the court be warranted in holding the claims unpatentable over a reference not identified by name and number.

For these reasons Finding 12, in holding the claims unpatentable, is error by the court.

The Conclusions of Law, in holding appellant not entitled to a patent on his invention, are urged to be in error for the reasons pointed out above.

H. CONCLUSION

Appellant urges that his claims are patentable because he has invented a new navigational system. No other system operates so successfully to keep a vehicle on the desired course. Appellant is the first to conceive and construct a navigational system wherein a series of modulation frequencies transmitted simultaneously from a plurality of pairs of reference stations is picked up on a moving vehicle and used to give a continuous and automatic indication of position.

The phase comparators which determine and produce this indication of position are clearly and fully disclosed in the specification and drawing, and by 35 U.S.C. 112 (third paragraph) the claims presented "shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof".

Thus, this section of the new patent code in effect inserts into the claims a definite recital of all of appellant's apparatus for determining and automatically indicating the difference in phase between the modulation frequencies received from the two stations of each pair of stations, as clearly and unmistabkably as if all these limitations were expressly recited in the claims. In effect, the section quoted limits the claims to appellant's particular apparatus "and equivalents thereof".

An equivalent is defined as a structure which does the same thing and does it in the same way as the structure for which it is alleged to be an equivalent. Obviously none of the reference devices meet this test. They do not do what appellant does, nor do they act in the same way to effect what they do purport to accomplish. None of them give automatic and continuous indications of position by means which may fairly be called equivalent to the means shown by appellant.

Under the provisions of 35 U.S.C. 112, the claims are not so broad that they may be properly dismissed as "offering nothing over X in view of Y", forcing together in such an unhallowed union any pair of references, no matter how incompatible they are to each other and to the invention under study.

Appellant's phase comparators are constructed to give continuous indications of position automatically. Claims have often been held patentable because they provide for automatic operation or indication:

In re Hendricks, 103 Fed. (2) 383.
Beattie v. Smith et al, 275 Fed. 164.
In re Hamilton, 64 Fed. (2) 141.
Bresnahan et al v. Tripp et al, 102 Fed. 899.

No better case than the present could be found for appreciating the advantages and actual necessity for automatic indication of position. The references relied on by the defense were issued many years ago when plane speeds were nothing like those of today and when the pilot or someone else in the plane could afford to take more time to determine position. But with the high speeds of the present day, if the indication is not prompt and automatic, it cannot really be depended upon at all. And none of the references offer a truly automatic indication of the difference in phase of a plurality of modulation frequencies.

Appellant has constructed the first phase comparator for use in a moving vehicle which will automatically indicate the difference in phase of a series of modulation frequencies and which can be read as easily as reading an electric meter. This new comparator is fully disclosed in the specification and drawings and by 35 U.S.C. 112 (third paragraph) it is embodied in the claims.

The structure of the present application is the first navigational system wherein a series of modulation frequencies transmitted simultaneously from a plurality of pairs of reference stations is picked up on the moving vehicle and by means of these new phase comparators gives an automatic continuous indication of the position of the vehicle.

Since the mechanism is completely automatic and requires no operator to manipulate any switches or controls of any kind, it can be mounted in guided missiles, where it will still give its indication of position with unfailing accuracy and can be connected to the control mechanism for holding the missile on its course.

The defense takes the position that appellant's mechanism offers nothing patentable over Shanklin or Holmes in view of Strobel. But these references offer no real anticipation of the invention. None of them do what appellant has done, and they are so incompatible that it is really impossible to combine them.

The Examiners in the Patent Office are far too prone to say that there is no invention in taking an idea from one patent and incorporating it in another, no matter how incompatible the two patents may be:

> no matter how many difficult changes in the structure of the other patent would be necessary;
>
> no matter that such a metamorphosis would require a complete reconstruction of the other mechanism;
>
> and no matter that, in actual fact, it would require, not the skill of a mechanic, but the creative ingenuity of an actual inventor to accomplish the many changes in the other structure which would be needed to produce the new device.

Appellant insists that his invention amounts to much more than this glibly recited "no invention over Shanklin or Holmes in view of Strobel".

But even if one were to concede that the Patent Office has correctly analyzed the issue, there is much respectable authority to the effect that many combinations of old elements are patentable:

> Where no one thought of combining elements in a new manner in order to achieve a particular unitary result the new device is patentable. Pointer v. Six-Wheel Corp., 177 Fed. (2) 153.
>
> If a new combination and arrangement of known elements produces a new and beneficial result, never attained before, it

indicates invention. Thornton v. Coe, Commissioner, 102 Fed. (2) 247.

Where such a combination satisfies an old and recognized want, invention should be inferred. Ibid. Also Carbide and Chemical Corp. v. Coe, Commissioner, 102 Fed. (2) 236.

Many things appear simple in afterthought, once some pioneering inventor has laboriously and painstakingly created some addition to human knowledge. The fact that a combination appears simple does not negative invention of a high order. Electrons, Inc. v. Coe (reversing the decision of the Patent Office and the trial Court) 99 Fed. (2) 414, 422.

Especially where no suggestion is found in the art, or in any reference cited, how to make the combination, the rejection will not be sustained. To use the gears of one patent in the tool of another to produce the structure of the claims, it would be necessary to reconstruct the device of the second patent, and there is nothing in either patent to show how that might be done. In re Arter (Court of Customs and Patent Appeals) reported in 64 Patents Quarterly 563.

Appellant asserts confidently that none of these prior patented devices have ever been built and put to the test of actual use. They are only paper patents, illustrating once again how often a pioneer patentee with an idea, perhaps only vaguely and confusedly envisioned, as in Holmes, can obtain a patent to block out the worth-while endeavors of later actual inventors who have labored to embody a workable invention in a fully operative device.

Appellant has devoted many years to the development and construction of a working model of his invention. He knows it is fully operative. In order to be accurate in operation the modulation frequencies which are used must be constant in phase. No mechanism was commercially available which would be phase-constant. Appellant had to invent his own mechanism for this purpose. While there are many known phase comparators, appellant could find none offered in the market which were reliable and efficient for airplane use in a system like the present. Again he had to invent his own.

The equities are all in appellant's favor. There is no evidence of any actual use of these alleged anticipating devices. The art had long sought in vain for such a means of guidance for an airplane in flight.

There is no actual anticipation of the invention claimed. The only rejection is on combinations of one patent with another, where such combinations could be actually built only with great difficulty and, as a practical matter, not at all. These alleged combinations were built up by the Patent Office only in the light of appellant's teachings and only for the purpose of defeating his just claims for a patent. The defense has offered no concrete suggestion as to how these discordant prior patents can be actually combined into one operating structure.

Appellant's device has been constructed and found successful in actual use.

The claims have been carefully worded to define appellant's invention. They are not anticipated.

It is submitted that they define a patentable invention and that the trial court erred in concluding otherwise and dismissing the bill.

Sound and long-established principles of law, as well as the inherent equities of the situation, demand a reversal of the decree below to the end that the Commissioner of Patents may be authorized and directed to issue to appellant the patent on the application here involved in accordance with the prayer of the bill.

Respectfully submitted,

Donald H. Jacobs, Pro Se

The Jacobs Instrument Company
Bethesda 14, Maryland

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RECORD APPENDIX

COMPLAINT
TO AUTHORIZE ISSUANCE OF LETTERS PATENT

To the Honorable the Judges of the United States District Court for the District of Columbia

1. This is a suit to obtain a patent under Section 145 of the Patent Act of 1952, 35 U.S.C. 145.

2. The plaintiff is a citizen of the United States and a resident of the State of Maryland, just across the D. C. border, so that his post office address is 4711 Overbrook Road, Washington 16, D.C.

3. The defendant is Commissioner of Patents, having his official residence in the District of Columbia, and is sued in his official capacity.

4. The plaintiff is the original and first inventor of an improvement in position finding and distance measuring systems, for which he duly made application for letters patent, the said application having been filed in the United States Patent Office on 18 November 1948 and receiving the Serial Number 60,731.

5. The said application was acted upon by the primary examiner who, on 17 August 1951 (and on 7 February 1952), entered a final rejection of claims 33, 37, and 60 to 64, inclusive, thereof.

6. On 8 February 1952 appeal was duly taken by the plaintiff to the Board of Appeals which on 30 November 1954 rendered its decision rejecting claims 33 and 37 on new grounds and affirming the Examiner's decision as to claims 60-64.

7. Thereupon, on 27 December 1954 request was made for reconsideration of this rejection and on 25 April 1955 the said Board of Appeals rendered its decision still maintaining the said grounds of rejection.

8. No appeal has been taken by the plaintiff to the United States Court of Customs and Patent Appeals.

9. By reason of the said decision of the Board of Appeals, the defendant has refused and still refuses to grant to the plaintiff a patent containing Claims 33, 37, and 60 to 64, inclusive, of application No. 60,731, although the plaintiff is lawfully entitled to such a patent.

10. Claims 1, 2, 16, 19, and 28 were also finally rejected by the Examiner but were omitted from the appeal to the Board of Appeals in the hope that they would grant the smaller number of claims submitted to them. Since it has become necessary to come before this Honorable Court in order to obtain a patent, and since plaintiff is fully convinced that these claims also are clearly patentable over anything cited by the Examiner, these claims 1, 2, 16, 19, and 28 are also included in this complaint.

WHEREFORE, plaintiff prays this Honorable Court to authorize the defendant, Commissioner of Patents, to issue to the plaintiff Letters Patent of the United States on the above-identified application containing claims 33, 37, 60 to 64, inclusive, 1, 2, 16, 19, and 28 of the said application, upon compliance by the plaintiff with the requirements of law.

Respectfully submitted,

Donald H. Jacobs
Plaintiff

Date: 10 May 1955

ANSWER TO THE COMPLAINT

To the Honorable the Judges of the United States District Court for the District of Columbia

1, 2, 3. The defendant admits the allegations of paragraphs 1, 2, and 3 of the complaint.

4. He denies that the plaintiff is the original and first inventor as alleged in paragraph 4. He admits the remaining allegations of that paragraph.

5, 6, 7, 8. He admits the allegations of paragraphs 5, 6, 7, and 8.

9. He admits that he has refused and still refuses to grant a patent as alleged in paragraph 9. He denies that the plaintiff is lawfully entitled to such a patent.

10. He states that the claims referred to in paragraph 10 were canceled from the application here involved at the request of the applicant and were not considered by the Board of Appeals. The Court is therefore without jurisdiction to pass on the patentability of those claims.

FURTHER ANSWERING, the defendant states that the plaintiff is not entitled to a patent containing any of the claims 33, 37, and 60-64, inclusive, of the application here involved for the reasons given and in view of the references cited in the Examiner's statement and the decisions of the Board of Appeals in the said application. Profert of copies of the said statement, decisions, and references is hereby made.

Respectfully submitted,

/s/ E. L. Reynolds
Solicitor, U. S. Patent Office,
Attorney for Defendant

May 17, 1955

I hereby certify that a copy of the foregoing ANSWER TO THE COMPLAINT was mailed today to Mr. Donald H. Jacobs, 4711 Overbrook Road, Washington, D. C. pro se.

/s/ E. L. Reynolds
Solicitor

THE CLAIMS*

33. Apparatus for determining the location of an unknown station relative to a plurality of reference stations comprising, at one of said reference stations, means for generating a plurality of modulation frequencies, means for generating and transmitting carrier wave energy, and equipment for impressing said modulation frequencies simultaneously on said energy; other of said reference stations comprising a receiver,

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* Claims Nos. 1, 2, 16, 19, and 28 were also prayed for in the Complaint, but are not included here because they were dismissed by the trial court, and that action is not being contested in this appeal.

a detector, means for generating a carrier wave of frequency different from that of any other carrier wave used in the apparatus and means for simultaneously impressing on said different carrier wave the modulations received from said one of said reference stations; and at the unknown station, receivers for each carrier wave frequency from each of said reference stations, detectors for each receiver, equipment to separate the modulation frequencies of the carrier wave received by each receiver, and devices for automatically comparing the phases of the modulations of the various received carrier waves.

37. Means for determining the location of an unknown point relative to a plurality of reference stations, comprising, at one of said stations, means for generating and transmitting carrier wave energy, equipment for impressing simultaneously on said wave energy a plurality of modulations arranged in series diminishing in frequency; other of said stations comprising a receiver for said modulated energy, together with means for generating and transmitting other wave energy of frequency different from that of any other station and means for simultaneously impressing on said other wave energy the modulations received from said one station; there being at the unknown point receivers for the wave energy from each station and means for automatically comparing the phase of the modulations of the various wave energies received from said stations.

60. A device for determining the location of a station relative to a plurality of reference stations, one of the reference stations comprising means for generating a plurality of modulation frequencies, means for generating carrier wave energy, and equipment for modulating said carrier energy simultaneously with said plurality of modulation frequencies; other reference stations each comprising a receiver for said modulated energy, a detector, a generator of different carrier wave energy, means for modulating said different carrier wave energy simultaneously with the plurality of modulation frequencies received from said one station and means for transmitting said modulated energy; the station

whose position is to be determined comprising receivers for each carrier wave energy from each of said reference stations, detectors for each receiver, equipment for the output of each receiver to separate the modulation frequencies of the carrier received by that receiver, and devices for comparing the phase of the modulations of the received carrier wave energies in pairs.

61. Apparatus for determining details of the positional relationship between a plurality of points in space consisting of a point of unknown location and a plurality of reference stations of known location comprising, means at one of said stations for generating carrier wave energy, for impressing thereon simultaneously a series of modulations successively diminishing in frequency and for transmitting the same, means at a plurality of said reference stations for receiving said modulated energy, for demodulating the same, impressing the modulations carried thereby on other carrier wave energy which is different for each station and retransmitting the same, and at the point of unknown location separate means for receiving each of said transmitted and retransmitted energies, and means for demodulating the same, and for determining the variation in phase of each of said modulations as received from each pair of stations.

62. Means for determining the position of a point of unknown location relative to a master station of known location and a plurality of reference stations, also of known location comprising, means at the master station for generating carrier wave energy, for generating a plurality of modulations arranged in series diminishing in frequency, for impressing said plurality of modulations simultaneously upon said carrier wave energy and transmitting the same, means at each of said reference stations for receiving said modulated energy, for generating different carrier wave energy, impressing the modulations carried thereby on said different carrier wave energy and retransmitting the same, and at the point of unknown location, separate means for receiving the energy transmitted from the master station and the energy re-

transmitted from the reference stations, detectors for demodulating the energies received, filters for separating the various modulations, phase comparators for comparing the phase of each of said modulations of the received energies and devices for automatically indicating the phase difference for each of said modulations from each pair of said stations.

63. Means for determining the position of a point of unknown location relative to a plurality of reference stations of known location comprising, means at certain of said reference stations for generating carrier wave energy, for generating a plurality of modulations arranged in series diminishing in frequency, for impressing said modulations simultaneously on said carrier wave energy and transmitting the same, means at others of said reference stations for receiving said modulated energy, for generating different carrier wave energy, impressing thereon the modulations carried by said first wave energy and retransmitting the same, and at the point of unknown location, separate means for receiving the energy transmitted from said certain of said stations and the energy retransmitted from said others of said stations, means for demodulating the wave energies received and phase sensitive devices for determining the difference in phase between corresponding modulations of the transmitted and retransmitted energies as received at the point of unknown location.

64. A system for guiding a vehicle in motion comprising a master station and a plurality of other stations, means at said master station for generating a series of modulations diminishing in frequency, for generating carrier wave energy, for impressing said series of modulations simultaneously on said carrier wave energy and for transmitting the same; means at each of said other stations for receiving said modulated energy, demodulating the same, impressing the modulations obtained therefrom on other carrier wave energy which is different for each station and retransmitting the same, and separate means on said vehicle for receiving the modulated energy from said master station and from said other stations, demodulating the same, comparing the

phase of the modulations received from each pair of stations and automatically indicating said difference in phase.

FINDINGS OF FACT

1. This is an action under 35 U.S.C. 145 in which the plaintiff, Donald H. Jacobs, seeks to have the Court authorize the allowance of claims 33, 37, and 60 through 64 of his application for patent Serial No. 60,731 for Position Finding and Distance Measuring Systems, which claims were refused by the Board of Appeals. Plaintiff further seeks to have the Court authorize the allowance of cancelled claims 1, 2, 16, 19, and 28 of said application, which claims were not included in the appeal to the Board of Appeals and were, therefore, not considered by that board. No claims in the application were allowed by the Patent Office.

2. Only claims 33, 37, and 60 through 64 specified in paragraph 9 of the complaint are before the Court on the merits.

3. The claims before the Court relate to a wave energy apparatus adapted for use in determining the position of a point of unknown location relative to two or more reference stations, and also for use in guiding an aircraft or other vehicle in motion.

As set forth in varying scope in claims 33 and 37, the apparatus includes 1) a first reference station including means for generating and transmitting a carrier wave, and means for impressing simultaneously a plurality of modulation frequencies on the carrier wave; 2) at least one other reference station including a receiver, means for generating a carrier wave of frequency different from that of any other carrier wave used in the apparatus, and means for simultaneously impressing on said different carrier wave the modulations received from said first reference station; and 3) a station of unknown location including receivers for each carrier wave frequency from said reference stations, and means for automatically comparing the phases of the modulations of the various received carrier waves. These claims do not specify more than two reference stations.

Claims 60 through 64 differ from claims 33 and 37 at least as follows: claims 60 through 64 require at least three reference stations; claims 60, 61, and 63 are not limited to automatic phase difference indicators, claim 64 requires that the unknown station equipment be mounted on a vehicle.

No claim sets forth that the unknown station equipment is mounted in an aircraft.

4. The patent to Holmes No. 2,198,113 discloses a method of determining the position of an unknown station by phase comparison of modulation frequencies and of navigating by hyperbolic iso-phase-difference curves, the apparatus for which includes a system of three reference stations, each transmitting a carrier wave different from that of the others, but having impressed thereon a common modulation frequency supplied from a source at one of the stations. The unknown station is disclosed as including apparatus simultaneously and separately to receive the modulation frequencies from any pair of the reference stations and simultaneously and automatically to indicate the phase difference for each pair.

5. The patent to Strobel No. 2,248,727 discloses the concept of and the apparatus for increasing precision of distance measurements by phase comparison of modulation frequencies wherein the same series of different modulation frequencies is simultaneously impressed on each of the different carrier waves for two stations and continuous and simultaneous phase comparison is made for each modulation frequency with respect to the two stations.

6. None of the plaintiff's application claims 33, 37, and 60 to 64 are limited to individual phase difference indicators having either a degree of accuracy or a degree of automatism distinguishable from Strobel's indicators used without manipulation of the reversing switches or distinguishable from Holmes' described automatic indicator.

7. The patent to Shanklin No. 2,144,203 describes at least two reference stations A and B transmitting different carrier waves, means

for impressing a plurality of synchronized modulation frequencies on each carrier wave, and means on a movable station for successively comparing the phase of each modulation frequency as received from a pair of reference stations.

8. No error is found in the holding of the Board of Appeals in its decision on reconsideration that, with respect to Fig. 7 of the Jacobs application, it could not be determined "from these diagrams or the cryptic description of these members in the instant specification how many manual switching and adjusting operations are necessary to make phase comparisons."

9. No patentable invention is involved in increasing the precision of the system of Holmes by substituting for his use of a single frequency modulation Strobel's multiple frequency modulation system with simultaneous and continuous indication.

10. Claims 33, 37, and 60 through 64 do not define patentable invention over Holmes in view of Strobel.

11. No error is found in the holding of the Board of Appeals that claims 33 and 37 do not define invention over Shanklin in view of Strobel.

12. Claims 33, 37, and 60 through 64 do not define patentable invention over the prior art.

CONCLUSIONS OF LAW

1. The Court is without jurisdiction to authorize the allowance of the cancelled claims which were not considered by the Board of Appeals.

2. Plaintiff having produced no significant new evidence relevant to the issues considered by the Board of Appeals, and having shown no clear error or lack of rational basis in the decision of the Board of Appeals, he is not entitled to prevail as to claims 33, 37, and 60 through 64.

3. Plaintiff is not entitled to a patent based on his application Serial No. 60,731 and containing any of claims 33, 37, and 60 through 64 and cancelled claims 1, 2, 16, 19, and 28 therein.

4. The complaint should be dismissed as to all the claims specified therein.

Judge

JUDGMENT

This action came on to be heard at this term and thereupon upon consideration thereof, it is this 6th day of March 1957,

ADJUDGED that the complaint be and it is hereby dismissed, with cost against the plaintiff.

Judge

February 27, 1957

I hereby certify that two copies of the foregoing FINDINGS OF FACT, CONCLUSIONS OF LAW AND JUDGMENT were mailed today, February 27, 1957, to the plaintiff, Mr. Donald H. Jacobs, 4711 Overbrook Road, Washington, D. C.

Solicitor

OPINION OF THE COURT

HOLTZOFF, J.

THE COURT: The plaintiff's invention as described in his application, to use his own words, "relates to a system for determining the position of an object such as an airplane, projectile, ship, or vehicle, whether moving or stationary, from a plurality of reference points. These reference points may be all stationary, or all moving, or some moving and some stationary."

The opinion of the Board of Examiners discusses the matter exhaustively. In addition, the Board of Examiners of the Patent Office wrote a further opinion in connection with the petition for reconsideration. The Patent Office held the plaintiff's invention unpatentable over a patent to Holmes, No. 2,198,113, issued April 23, 1940, in view of a patent to Strobel, No. 2,248,727, issued on July 8, 1941.

The Board of Examiners points out that Holmes describes an apparatus and a method, under which "by radiating modulation waves from a plurality of known positions and receiving said waves at an unknown position the location of the unknown position may be determined by comparing the phase difference between the modulation frequencies carried by the various carrier waves in traveling from the known position to radio receivers at the unknown position."

The Board further points out that there is only one feature in the applicant's application that is not shown in the prior patent to Holmes and that this feature is the use of several modulating frequencies diminishing in amplitude. The Board points out, however, that this additional feature is shown in Strobel. The Strobel patent contains a statement on page 3, column 2, beginning at line 69 reading as follows: "For continuous indications which may be interpreted with the greatest rapidity it may be desirable to make the low frequency reading and the high frequency reading simultaneously."

The applicant contended in the Patent Office that two references, such as the Holmes and the Strobel patent, could not be taken together for the purpose of barring the issuance of a patent to this applicant. That point is not well founded and the practice followed in this respect by the Patent Office is well established and has been often approved.

The Court finds no reason for differing from the position of the Patent Office that the claims in suit are not patentable over Holmes in view of Strobel. In view of these considerations, the Court will render judgment for the defendant dismissing the complaint on the merits. Counsel may submit proposed findings of fact and conclusions of law and a judgment.

Will you do that within two or three days?

MR. ROEMING: Yes, Your Honor.

THE COURT: The Court wishes to thank both sides for a very interesting and able presentation.

(Thereupon the trial was concluded.)

7 February 1957

STATUTORY APPENDIX

The following provisions of Title 35, United States Code provide:

Section 112 (Third Paragraph)

An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

Section 132

Notice of rejection; reexamination. Whenever, on examination, any claim for a patent is rejected, or any objection or requirement made, the Commissioner shall notify the applicant thereof, stating the reasons for such rejection, or objection or requirement, together with such information and references as may be useful in judging of the propriety of continuing the prosecution of his application; and if after receiving such notice, the applicant persists in his claim for a patent, with or without amendment, the application shall be reexamined. No amendment shall introduce new matter into the disclosure of the invention.

Section 145

Civil Action to obtain patent. An applicant dissatisfied with the decision of the Board of Appeals may unless appeal has been taken to the United States Court of Customs and Patent Appeals, have remedy by civil action against the Commissioner in the United States District Court for the District of Columbia if commenced within such time after such decision, not less than sixty days, as the Commissioner appoints. The court may adjudge that such applicant is entitled to receive a patent for his invention, as specified in any of his claims involved in the decision of the Board of Appeals, as the facts in the case may appear and such adjudication shall authorize the Commissioner to issue such patent on compliance with the requirements of law. All the expenses of the proceedings shall be paid by the applicant.

United States Court of Appeals
For the
District of Columbia Circuit

FILED DEC 19 1957

Joseph W. Stewart
CLERK

BRIEF AND APPENDIX FOR APPELLEE

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA CIRCUIT

APPEAL NO. 13,902

DONALD H. JACOBS, APPELLANT

v.

ROBERT C. WATSON, COMMISSIONER OF PATENTS,
APPELLEE

APPEAL FROM THE JUDGMENT OF THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF COLUMBIA

CLARENCE W. MOORE,
Solicitor,
United States Patent Office,
Attorney for Appellee.

GEORGE C. ROEMING,
Of Counsel.

APPEAL NO. 13,902

STATEMENTS OF QUESTIONS PRESENTED

In the opinion of appellee, the questions presented on this appeal are:

(1) Was there a rational basis for the finding of the District Court that, on all the evidence before it, all the claims in suit are not patentable over the patent to Holmes No. 2,198,113 in view of the patent to Strobel No. 2,248,727?

(2) On all the evidence before it, was there a rational basis for the District Court's finding of no error in the holding of the Board of Appeals that claims 33 and 37 do not define invention over the patent to Shanklin No. 2,144,203 in view of the patent to Strobel No. 2,248,727?

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United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA CIRCUIT

APPEAL NO. 13,902

DONALD H. JACOBS, APPELLANT

v.

ROBERT C. WATSON, COMMISSIONER OF PATENTS,
APPELLEE

APPEAL FROM THE JUDGMENT OF THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF COLUMBIA

BRIEF FOR THE COMMISSIONER OF PATENTS

INTRODUCTION

This is an appeal from the judgment (Apt. A. 10) of the United States District Court for the District of Columbia dismissing the complaint (Apt. A. 1) in an action brought under 35 U. S. C. 145. In that action appellant, as the applicant in an application for patent (Ae. A. 1a) entitled "Position Finding and Distance Measuring Systems," Serial No. 60,731, filed November 18, 1948, sought to have that Court authorize the issuance to him of a patent containing claims 33, 37, and 60 through 64 (Apt. A. 3–7), which are the only claims remaining in the application, and containing also claims 1, 2, 16, 19, and 28, which after the final rejection by the examiner were cancelled at appellant's direction in paper 18 of the application (Appellant's Exhibit 1) and were not included in the appeal to the Board of Appeals.

The District Court concurred with the examiner and the Board of Appeals in their refusal (Ae. A. 21a and 27a) of claims 33, 37, and 60 through 64, as unpatentable over prior art (Apt. A. 9, Findings of Fact Nos. 10 through 12), and concluded that it was without jurisdiction to authorize the allowance of the cancelled claims which were not considered by the Board of Appeals (Apt. A. 9, Conclusion of Law No. 1). On this appeal the dismissal of the complaint as to cancelled claims 1, 2, 16, 19, and 28 is not challenged by appellant (Apt. A. 3, footnote).

APPELLANT'S APPLICATION

Fig. 1 of appellant's application illustrates the previously known principle of measuring distances by comparison of the phase of a given wave at various points. Appellant's specification explains this old principal in great detail (Ae. A. 3a). It also describes various position finding systems based on this old principle with addition of refinement of accuracy by application to a carrier wave of a series of modulation frequencies whose respective wave lengths may be related to each other in a ratio, for example, of 10 to 1 (Ae. A. 5a). Figs. 4, 5, 8, 9, and 10 of appellant's application (Ae. A. 15a) disclose various species of such systems. Appellant elected to prosecute in the application at bar claims readable on the species of Fig. 10. That species is best described in detail in appellant's specification (Ae. A. 12a). Fig. 7 illustrates and the specification (Ae. A. 10a) describes a "representative means for making a comparison of phase at each modulation frequency" (Ae. A. 8a). The specification admits (Ae. A. 10a): "Many methods for accomplishing this are known to the art. A special method of making this phase comparison will be described." There is no contention in any part of appellant's specification as filed that his disclosed means of making phase comparisons is critical or is superior to the "many methods for accomplishing this * * * known to the art." This point is particularly emphasized since appellant's description of his development in his brief (pages 7 through 12), with its emphasis on simultaneous, continuous and automatic phase comparison, is a description of that development as he sees it now, rather than a description of what he disclosed in his application specification and original claims. None of the latter recited even means for merely automatically comparing the phase of the modulations of the various received carrier waves.

THE PRIOR ART

Appellant at page 12 of his brief discusses the patent to Nosker No. 2,470,787. Since the Board of Appeals did not sustain the examiner's ground of rejection involving the Nosker patent and since the District Court made no finding involving that patent, it will not be further discussed in this brief.

The patent to Holmes No. 2,198,113 discloses a method of determining the position of an unknown station by phase comparison of modulation frequencies and of navigating by hyperbolic iso-phase-difference curves, the apparatus for which includes a system of three reference stations, each transmitting a carrier wave different from that of the others, but having impressed thereon a common modulation frequency supplied from a source at one of the stations. The unknown station is disclosed as including apparatus simultaneously and separately to receive the modulation frequencies from any pair of the reference stations and simultaneously and automatically to indicate the phase difference for each pair (Finding of Fact No. 4, Apt. A. 8).

The patent to Strobel No. 2,248,727 discloses the concept of and the apparatus for increasing precision of distance measurements by phase comparison of modulation frequencies wherein the same series of different modulation frequencies is simultaneously impressed on each of the different carrier waves for two stations and continuous and simultaneous phase comparison is made for each modulation frequency with respect to the two stations (Finding of Fact No. 5, Apt. A. 8).

The patent to Shanklin No. 2,144,203 describes at least two reference stations A and B transmitting different carrier waves, means for impressing a plurality of synchronized modulation frequencies on each carrier wave, and means on a movable station for successively comparing the phase of each modulation frequency as received from a pair of reference stations (Finding of Fact No. 7, Apt. A. 8).

STATUTE INVOLVED

35 U. S. C. 112. Specification.

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

PATENT OFFICE RULE INVOLVED

Rule 196. Decision by the Board of Appeals. * * *

(b) Should the Board of Appeals have knowledge of any grounds not involved in the appeal for rejecting any claim, it may include in its decision a statement to that effect with its reasons for so holding which statement shall constitute a rejection of the claims. The appellant may submit an appropriate amendment of the claims so rejected or a showing of facts, or both, and have the matter reconsidered by the primary examiner. The statement shall be binding upon the primary examiner unless an amendment or a showing of facts not previously of record be made which, in the opinion of the primary examiner, avoids the additional ground for rejection stated in the decision. The applicant may waive such reconsideration before the primary examiner and have the case reconsidered by the Board of Appeals upon the same record before them. Where request for such reconsideration is made the Board of Appeals shall, if necessary, render a new decision which shall include all grounds upon which a patent is refused. The applicant may waive reconsideration by the Board of Appeals and treat the decision, including the added grounds for rejection given by the Board of Appeals as a final decision in the case. * * *

SUMMARY OF ARGUMENT

1. Where the patent to Holmes discloses a system of position finding by phase comparison of the same modulation frequency imposed on different carrier waves transmitted from each of a plurality of reference stations, and Strobel discloses a system for increasing precision of phase-comparison distance-measurement by simultaneous and continuous phase comparison indication of multiple modulation frequencies impressed on the carrier waves, no patentable substance is involved in incorporating in the system of Holmes the increased precision system of Strobel; and therefore all the claims at bar are unpatentable.

2. Where the patent to Shanklin discloses a system of position finding by phase comparison of multiple modulation frequencies impressed on different carrier

waves transmitted from each of a plurality of reference stations, and Strobel discloses simultaneous and continuous phase comparison indication for all the frequencies of a series, no patentable substance is involved in incorporating in the system of Shanklin the simultaneous and continuous indication of Strobel; and therefore claims 33 and 37 are unpatentable.

ARGUMENT

History of appellant's application

Appellant appears to complain that he was procedurally unfairly treated by both the Patent Office and the District Court.

An applicant for patent who in the Patent Office presents sixty-four claims in his application, appeals from the refusal of only seven of those claims, and declines to take advantage of his right to further prosecution under Patent Office Rule 196 (b) makes out a very weak case of unfair treatment.

In the District Court, appellant declined to follow the advice of the Court that he procure the services of an attorney for proper presentation of his case (Ae. A. 45a, 46a).

In view of the statement in the last sentence of page 3 of appellant's brief, attention is directed to the pertinent portion of the transcript of the record of the trial (Ae. A. 48a).

Appellant's statement (brief, page 3, line 7) that the "Court refused to read the plaintiff's memorandum" is challenged as inaccurate. If appellant had wanted seriously to make the above-quoted charge before this Court, he should have included in the record a transcript of the pertinent proceedings in open court and printed it in his appendix under the provisions of Rule 17 (c) (11). Such transcript would show that Judge Holtzoff examined appellant's memorandum and made pertinent comments as to its substance.

Appellant's motion for a new trial (referred to in appellant's brief, pages 3 and 7) stated grounds which no District Court could reasonably have found sufficient to justify a new trial. If appellant had any just ground for complaint on this point, he should have appealed from the denial of the motion and printed the motion and the supporting points and authorities in his appendix so that this Court could read them [Rule 17 (c) (11) of this Court].

It is submitted that the record shows that the District Court gave appellant more sympathetic procedural treatment that he was entitled to as a matter of right.

Appellant's statement of questions presented

All three of appellant's questions indicate a misconception of 1) the nature of a civil action under 35 U. S. C. 145 (the successor action to the old bill in equity under R. S. 4915), and 2) the appellant's burden of proof in such action. In *Abbott et al.* v. *Coe,* 71 App. D. C. 195, 109 F. 2d 449, this Court stated:

> Although a court, when it agrees with a Patent Office finding, often says so, agreement is not necessary to affirmance and disagreement is not sufficient for reversal. The question for us is not whether in our opinion there was in-

> vention, but whether the finding that there was none is consistent with the evidence.

See also *Dyer* v. *Coe,* 75 U. S. App. D. C. 125, 125 F. 2d 192; *Potts* v. *Coe,* 78 U. S. App. D. C. 297, 140 F. 2d 470; *Esso Standard Oil Co.* v. *Sun Oil Co.,* 97 U. S. App. D. C. 154, 229 F. 2d 37; *U. S.* v. *Szuecs,* — U. S. App. D. C. —, 240 F. 2d 886. Accordingly, appellant has the burden not merely of convincing this Court on a preponderance of evidence that he has disclosed and claimed in his application patentable substance; he has the far heavier burden of proving that there was no rational basis in the evidence before the District Court for its decision when it either agreed with the Patent Office tribunals or found no clear error in their holdings.

At the trial, upon the introduction in evidence of the application record and the prior art references relied on, appellant had the burden of going forward either 1) with or without new evidence to prove clear error by the Patent Office tribunals or 2) of introducing new evidence throwing a new light on the questions decided by the Patent Office tribunals to overcome the presumption of correctness. Unless appellant sustained that burden of going forward, appellee, without adducing additional evidence of any kind, was entitled to judgment dismissing the complaint. Thus appellant's first question is fully answered.

Appellant's third question is ambiguous in the terminology "properly rejected." To be consistent with the above-mentioned decisions, this terminology must be construed to mean "rejected without clear error and rejected properly in the light of new evidence before the District Court."

Appellant's second question relates to the fact that counsel for appellee in argument at the trial relied on portions of the Holmes patent disclosure which had not previously been mentioned in the application record by either the examiner or the Board of Appeals in their respective discussions of that patent. The Holmes patent was one of "the references cited in the Examiner's Statement and the decision of the Board of Appeals" in appellant's application and was therefore pleaded in the last paragraph of the answer to the complaint (Apt. A. 3, paragraph 2). Thus appellee's reliance at the trial on any portion of the Holmes patent was not a new ground. Even in appeals on the Patent Office record to the Court of Customs and Patent Appeals, that Court in deciding the appeal issues will consider portions of patent disclosures other than those relied on by the Patent Office tribunals. *In re Hall,* 41 C. C. P. A. 759, 763, 208 F. 2d 370; *In re Osse,* 28 C. C. P. A. 1267, 120 F. 2d 1022; *In re Stinson,* 33 C. C. P. A. 853, 154 F. 2d 121; *In re Mosher,* 23 C. C. P. A. 740, 79 F. 2d 911. In *American Steel and Wire Co.* v. *Coe,* 70 App. D. C. 138, 105 F. 2d 17, this Court approved the action of the District Court in relying on a patent not pleaded in appellee's answer and introduced to the record by the appellant. In that case this Court characterized as "remarkable" the appellant's contention that the reference should not have been considered as a basis for dismissal of the bill. Also pertinent to instant appellant's second question is the following statement in *In re Kuhn et al.*, 32 C. C. P. A. 1110, 150 F. 2d 145:

> With respect to appellant's complaint as to the use of the references by the Patent Office, it may be well to call attention to the fact that the object of an inventor who applies for a patent should be not only to obtain a patent for his invention, but also to obtain a valid patent that will not be subject to a successful subsequent attack * * *.

When instant appellant asked the District Court to authorize the issuance of a patent containing the claims at bar, it was incumbent upon him to be familiar with the complete disclosure of each of the reference patents before he contended to the District Court that the disclosure of any one of those patents was insufficient to be relied on in the refusal of his claims. Thus, appellant's second question also stands fully answered.

Appellant's testimony

In addition to the copy of appellant's application, the only evidence adduced by appellant was his own testimony. That testimony was primarily devoted to explanation of appellant's specification disclosure and to arguments as to the reference patents. Appellant's testimony adduced no facts indicating error in the decisions of the Patent Office tribunals.

Appellant's brief clearly indicates his familiarity with the patent statutes and with the rules of practice of the Patent Office. There is nothing in the record to indicate that appellant is any less familiar with the rules of this Court. Rule 17 (c) (11) of those rules requires that appellant shall print in the appendix to his brief such parts of the record relevant to the questions presented as the appellant desires the Court to read. Appellant himself evidently considers his own testimony at the trial of so little value to his case, that he not only has not printed any of it in his appendix for this Court to read, but has made no reference whatever to it in his brief.

Accordingly, appellant must base his case on a demonstration of clear error in the decisions of the Patent Office tribunals and the District Court.

The claims at bar

An analysis of appellant's claims (Apt. A. 3 through 7) is found in Finding of Fact No. 3 (Apt. A. 7 and 8) to which appellant has made no objection. In view of appellant's repeated emphasis in his brief on alleged "simultaneous and continuous indication" in the apparatus of his own specification, it is noted that none of his claims are limited expressly to such indication. The terminology "devices for *automatically indicating* the phase difference for each of said modulations from *each pair* of said stations" is set forth in claim 62; and the terminology "*separate* means * * * for comparing the phase of the modulations received from *each pair* of stations and *automatically indicating* said difference in phase" is set forth in claim 64 (in the quotations emphasis is added). These claims require automatic indication for each pair of stations. Under the broadest literal interpretation of such terminology, it could reasonably be maintained that it does not exclude automatic successive indication for each pair of stations. That point will not be pressed here; but appellee concedes only that for purposes of claiming "simultaneous and continuous indication" claims 62 and 64 set forth more effective terminology than do the other claims at bar. Claims 60, 61, and 63 are clearly not limited to automatic or indicating phase-difference-measuring devices and are clearly not limited to "simultaneous and continuous indication." Claims 33 and 37 recite automatic comparison means but in language so broad that it would clearly read on one indicating or automatic phase difference meter used for *successively* determining phase difference for *less than all* pairs of reference stations.

None of the claims at bar specifies any degree of precision in the phase comparison means.

At pages 29 and 35 of his brief, appellant contends that under 35 U. S. C. 112, paragraph 3, claim terminology such as "means for determining the difference in phase" etc., must be construed to mean all the specific elements of his disclosure upon which that terminology is broadly readable. That contention is not sustainable in view of paragraph 2 of 35 U. S. C. 112. *In re Lundberg et al.,* 44 C. C. P. A. 909, 244 F. 2d 543; *Siegel* v. *Watson,* — F. Supp. —; Civil Action No. 2969–54, U. S. District Court for the District of Columbia, decided November 26, 1957, Curran, J. Paraphrasing language in the *Lundberg* case, it might be said that appellant here could not have contemplated his present interpretation of paragraph 3 of Section 112 when he drew the claims at bar involving both broad and narrow limitations involving the phase comparators.

Finding of Fact No. 4

The finding relates to the disclosure of the Holmes patent No. 2,198,113. That disclosure, particularly as it pertains to Figs. 2, 4, 5, and 6, is analyzed in detail in the decision of the Board of Appeals (Ae. A 31a). The following features of the Holmes disclosure are noted for emphasis and in answer to specific contentions in appellant's brief.

Holmes states (at page 5, column 2, lines 53 through 59) that in Fig. 4, the "carrier waves radiated from one pair" of stations, such as 37 and 38, "may be the same and a different carrier wave frequency may be used for the other pair," such as 35, 36. The description in Holmes, page 5, column 2, line 70 through page 6, column 1, line 34, obviously pertains to such carrier wave arrangement. If, in that arrangement, modulation frequency phase comparison is first made between stations 35 and 36 having one carrier frequency and then between stations 37 and 38 having another carrier wave frequency, only one receiver 41a is necessary. But even for that arrangement, Holmes states (page 6, column 1, lines 26 through 31):

> Obviously the mobile *receiving equipment* may include *means to receive* the waves *substantially simultaneously* from both pairs of stations and the phase angle indicator 41b may include means for *simultaneously* producing two sets of perceptible indications. [Emphasis added.]

Holmes in Fig 2 (and at page 3, column 2, lines 62 and 63) discloses (as appellant admits at page 18, lines 7 and 8 of his brief) that two receivers 17 and 18 are required for receiving two carrier waves of different frequencies. It therefore follows that in the above quotation "means to receive the waves substantially simultaneously from both pairs of stations" would require two receivers in the equipment 41, namely, one for each of the two carrier waves employed by the two pairs of stations.

But Holmes also discloses (at page 5, column 2, lines 49 through 53) that in the apparatus of his Fig. 4, the carrier waves supplied by each of the stations may differ from one another "so that they may be *separately received.*" [Emphasis added.] In such modification, separate reception of two of the four different carrier waves for phase comparison purposes obviously would require two receivers (as in Fig. 2) in the receiving equipment 41 and separate reception of all four carrier waves would require four receivers in equipment 41.

It is submitted that the above conclusively demonstrates that appellant's repeated contentions about "one receiver" (brief, pages 19, 21, 25, 26) are lacking in significant substance.

Fig. 5 of Holmes discloses patterns of hyperbolic iso-phase-difference lines for the four-reference-station system of Fig. 4. These lines may be superimposed on a map to be used in air navigation.

Fig. 6 of Holmes discloses a three-reference-station system and a corresponding pattern of iso-phase-difference lines. In that system there may be used *any* of the receiving and transmitting arrangements previously described in relation to Figs. 1 through 5 (Holmes, page 6, column 1, lines 62 through 66). For the system of Fig. 6, the carrier wave frequencies of stations 35, 36, and 37 are disclosed as "preferably different" (Holmes, page 6, column 1, lines 60 through 62). Therefore, the station of unknown location must have separate receivers for each of the different carrier waves (see the above demonstration involving Fig. 2). But the modulation frequency is the same for all the stations (Holmes, page 6, column 1, lines 56 through 60). For indication of phase difference (suggested at page 6, column 1, lines 45 through 51) which is simultaneous and continuous (as suggested at page 6, column 1, lines 26 through 39), there would be required in the system of Fig. 6 as many indicating or automatic phase meters as there are pairs of stations whose phase difference is to be compared. Holmes teaches (page 6, column 1, lines 47 through 51) that, in the system of Fig. 6, phase difference of "*any* one pair of stations" (emphasis added) is to be used with the phase difference of another pair of stations to determine position. Where simultaneous indication is provided in this system, and *any* pair may be one of the two pairs of stations involved, it follows that an indicating phase meter is required at the unknown station for each pair of reference stations (as found in the last sentence of Finding of Fact No. 4 with reference to the last four lines of claim 64).

However, Holmes clearly discloses that position can be determined by making phase comparisons for only two of three possible pairs of stations in the system of

Fig. 6. It follows that the requirement of claim 64 that there be automatic indication for "each pair of stations" is not shown to be a significant limitation. Accordingly, if clear error could be demonstrated in the terminology "for each pair" at the end of Finding of Fact No. 4, such error would be immaterial.

It is noted that appellant (at page 22 of his brief) tries, unconvincingly, to show significance in the difference between the terminology "substantially simultaneously" and "simultaneously" at Holmes, page 6, column 1, lines 28 and 30. Appellant at page 22, first full paragraph, of his brief further alleges indefiniteness in Holmes' use of the word "compared" in the patent at page 6, column 1, line 48. It is submitted that any reasonable person reading the sentence containing that word and the following sentence would understand that the words "compared with," as there used, were intended to mean the equivalent of "used in cordination with." Attention is directed to appellant's own ambiguous use of the term "comparing" in the terminology "comparing the phase of each of said modulations of the received energies" in claim 62, last three lines (Apt. A. 6).

Holmes (at page 6, column 1, lines 26 through 39; page 6, column 2, line 60 through page 7, column 1, line 69; and page 3, column 1, lines 29 through 38) also discloses the concept of and apparatus for simultaneous, continuous and automatic phase indication. It is noted that at the above-noted lines of page 3, Holmes states:

> The phase angle indicator may comprise a direct reading indicator, such as a modified

> cross coil Tuma indicator or it may comprise a *cathode ray tube* with one set of deflection plates connected to the output of the receiver and the other set of plates connected to the modulation source 2. In any event the *literature is replete* with indicating phase angle meters and the most advantageous meter is *a matter of selection.* [Emphasis added.]

Appellant at pages 20, 23, and 24 of his brief attacks the Holmes disclosures of indicating or automatic phase angle meters. But he adduced no testimony or other evidence at the trial to demonstrate inoperativeness of any of the indicating phase angle meters described by Holmes. In his brief appellant avoids contradicting Holmes' statement (as of his filing date, Sept. 30, 1938) that "the literature is replete with indicating phase angle meters". Appellant states merely that he "could not find any *commercially available* phase angle indicator" which he considered suitable for his purpose (brief, page 20, last seven lines, emphasis added; see also brief, page 39, first two lines). Furthermore in his own specification (Ae. A. 8a), appellant states, as previously noted, that his Fig. 7 is a disclosure of a "representative means for making a comparison of phase at each modulation frequency". He also states (Ae. A. 10a):

> Many methods for accomplishing this are known to the art. A special method of making this phase comparison will be described.

It thus clearly appears that, even if *all* the indicating phase angle meters as disclosed in *all* of the patents of record had been proved inoperative to the extent that one skilled in the art could not make them operative (*Western States Machinery Co.* v. *S. S. Hepworth Co.,* 147 F. 2d 345, 350; *Bullard et al.* v. *Coe,* 79 U. S. App. D. C. 369, 147 F. 2d 568), that fact would be immaterial in view of the further fact that Holmes in 1938 stated and appellant in his specification (as filed in 1948) admitted that indicating phase angle meters are known to the art. Pertinent here is the following quotation from Judge Learned Hand's decision in the *Western States Machinery Co.* case, *supra:*

> When the examiner passed the disclosure, he must have agreed that it was unnecessary to show the "suitable means"; and there is no reason to think that he was wrong. Those decisions which we have already cited to show that a patent is presumed to be operable, apply also to the sufficiency of the disclosure to advise the art.

It is therefore submitted that there is no error of any kind in Finding of Fact No. 4.

Even if clear error in any respect could be demonstrated in Finding of Fact No. 4, that error would be immaterial if it related only to substance not set forth in the claims. For example, as previously demonstrated, claims 60, 61, and 63 are not limited to *automatic* phase difference indicators. Only claims 62 and 64 could reasonably be alleged to set forth apparatus for *simultaneous* as well as automatic indication of phase difference *for each pair* of reference stations. Obviously, it is immaterial to the issue of patentability of the claims if the references do not disclose features not set forth in the claims. An independent finding by this Court that Holmes disclosed all the substance of Finding of Fact No. 4 except immaterial features, or features not definitely set forth in the claims, would not be cause for reversing the judgment of the lower court.

Finding of Fact No. 5

Appellant (brief, page 16) admits that the patent to Strobel discloses the use of a series of modulation frequencies and that it explains (Strobel, page 3, column 1, lines 35 to 70) how a higher frequency gives greater precision in the measurement. Appellant, however, contends that Strobel does not compare these frequencies simultaneously or automatically. Strobel (page 3, column 2, line 69 *et seq.*) states:

> For *continuous indications* which may be interpreted with the greatest rapidity it may be desirable to make the low frequency reading and the high frequency reading *simultaneously*.

Strobel's device for continuous indication is disclosed not in Fig. 2 (in appellant's brief, page 16, paragraph 4, and page 28, lines 4 and 5 are irrelevant), but in Fig. 3 and Fig. 6 (see Strobel, page 3, column 1, last line *et seq.*). Strobel's phase meter for "continuous indication" requires preliminary adjustment of resistors 38, 39. Thereafter it provides continuous indication but with variation of precision as indicated on curve 50 of Fig. 4 (Strobel, page 3, column 2, lines 21 through 24). *The degree of precision of the phase comparison indicators is defined neither in appellant's claims at bar nor in Finding of Fact No. 5.* Moreover, appellant does not allege any specific degree of precision in his specification for the comparator of his own Fig. 7. In his specification (Ae. A. 5a) appellant assumes that the indication of the phase comparator to be used is accurate only to within 2°. Accordingly, although Strobel (page 3, column 2, lines 28 *et seq.*) provides a reversing switch to increase the precision on a portion of the curve 50 of Fig. 4 and also *may* vary the frequency *if he should happen to be in doubt* as to whether a reading corresponds to points a or b of the curve 50, those facts are immaterial since those devices and procedures need not be used to provide the simultaneous and continuous indication specified in Finding of Fact No. 5 and the automatic indication specified in appellant's claims 33, 37, 62, and 64. Even when the reversing switch and the frequency manipulation devices are used, such uses involve merely preliminary adjustments which are followed by continuous indication. The examiner was obviously correct when, in the final rejection in the application at bar (Plaintiff's Exhibit 1, page 73 or paper 13, page 2), he stated:

> * * * Strobel refers to a modification in which the phase is read directly from the meter. This is "automatic" indication of phase. The adjustments mentioned by Strobel are adjustments to compensate for phase shifts in the apparatus which would not have to be repeated for each reading or adjustments for increasing the accuracy. Applicant's own system would undoubtedly require some adjustment.

Furthermore, it will be obvious from reading Strobel, page 3, entire column 2, that the method of obtaining increased precision by multiple frequencies (described in the third full paragraph) may be an alternative to the method of obtaining increased precision without multiple frequencies (described in the second full paragraph).

In the absence of convincing evidence to the contrary, it must be presumed that Strobel's patent sufficiently discloses apparatus for performing the described function of continuous and simultaneous phase difference indication for the various modulation frequencies. *Western States Machinery Co.* v. *S. S. Hepworth Co., supra.*

Even if appellant has proved, by testimony or other competent evidence, that Strobel's disclosed apparatus could not be used by one skilled in the art to perform Strobel's stated continuous and simultaneous indication, appellant would still be faced with Holmes' statement that "the literature is replete with indicating phase angle meters" and appellant's own admission in his specification that "many methods for accomplishing this are known to the art." See also Shanklin, page 1, column 2, lines 5 through 11.

It is submitted that appellant has demonstrated no error in Finding of Fact No. 5. As indicated above at the end of the discussion of Finding of Fact No. 4, even if error in any respect could be demonstrated in this finding, that error would be immaterial if it related only to substance not set forth in the claims.

Finding of Fact No. 6

This finding notes the fact that none of the claims are limited to individual phase difference indicators having either a degree of accuracy or a decree of automatism distinguishable from Strobel's indicators used without manipulation of the reversing switches or distinguishable from Holmes' described automatic indicator.

This point has already been completely covered in the above discussions of Findings of Fact Nos. 4 and 5.

Appellant's argument in his brief at page 28, first paragraph, is irrelevant to the issues raised by his claims (as previously demonstrated). It is also inaccurate in its details (same paragraph, lines 4 through 7) since Strobel's device of page 2, column 2, lines 68 and 69, is a device separate and different from that of page 3, column 2, lines 4 and 5. Thus Strobel discloses no one apparatus in which a phase shifter 31 is first adjusted and *then* resistors 38 and 39 are adjusted.

As to page 28, paragraph 2, of appellant's brief, it is noted that appellee has made no argument that any part of Strobel's apparatus need be *eliminated.* It has been previously demonstrated that the use of Strobel's precision refinement devices is optional and is not required to meet appellant's claims.

As to page 28, last paragraph, of his brief, appellant repeats his arguments as to this reference which have been discussed with respect to Finding of Fact No. 4. Obviously, Holmes' indicator includes not only the operative indicator of his Figs. 8 and 9 but also those of his page 3, column 1, lines 29 through 38.

Appellant also resorts at page 29 of his brief to the unsustainable interpretation of 35 U. S. C. 112, paragraph 3, which has previously been fully discussed under the heading "The Claims at Bar." *In re Lundberg, supra; Siegel* v. *Watson, supra.*

It is submitted that Finding of Fact No. 6 is free of any error.

Finding of Fact No. 7

The patent to Shanklin No. 2,144,203 involved in this finding is thoroughly analyzed in the decision of the Board of Appeals (Ae. A. 37a *et seq.*). Appellant at page 39 of his brief alleges no error in Finding of Fact No. 7.

However, at pages 13 and 14 of his brief, appellant makes inaccurate statements about the Shanklin disclosure which will be discussed in detail under Finding of Fact No. 11.

Finding of Fact No. 8

This finding involves the next to the last paragraph of the decision on reconsideration by the Board of Appeals (Ae. A. 45a), specifically the statement:

> * * * (2) the filter member and phase comparator is shown in the instant drawing as a block diagram or as a section through a cathode ray tube and we are unable to determine from these diagrams or the cryptic description of these members in the instant specification how many manual switching and adjusting operations are necessary to make these comparisons.

In the final rejection, the examiner had stated (see previous more complete quotation at page 21 of this brief): "Applicant's own system would undoubtedly require some adjustment."

Appellant in the specification description of his phase meter of Fig. 7 makes no allegation that his device requires no adjustment prior to or during use for its intended purpose. At the trial appellant adduced no evidence of any kind to establish that the *disclosure* of his phase meter *in his application* is such that anyone skilled in the art would in following its teachings inevitably produce a phase meter *requiring no adjustment of any kind.* See *Fletcher* v. *Watson,* 92 U. S. App. D. C. 205, 204 F. 2d 68. Appellant states in his brief at page 30, last paragraph: "No adjustments of the apparatus are necessary." On this issue, distinction must be drawn between what appellant claims to have built in his shop and what he has disclosed in his application. Appellant has clearly failed to establish error in the above-quoted holdings of either the Board of Appeals or of the examiner.

Appellant at pages 30 and 31 of his brief states:

> No objection as to the clearness of disclosure was raised at any time during the years the application was prosecuted until the last page of the last action by the Patent Office. It is urged that this objection is clearly unwarranted and also is raised too late, and that the Court's endorsement of this holding was error by the trial court.

The issue here is not whether the Patent Office actions were procedurally correct. The issue is whether or not appellant was entitled to have patenting authorized by the District Court. However, it is noted that in the above-quoted excerpt from the examiner's final rejection (which was followed by a series of examiner's letters disposing of appellant's later presented claims) the point here involved was raised, not as a basis *per se* for rejection, but to show *lack of patentable distinction* over a pertinent reference patent. Furthermore, as clearly indicated in the decision of the Board of Appeals, claims 33 and 37 were rejected by the Board on new grounds under Rule 196 (b) and appellant's attention was specifically directed by the Board to the fact that he was entitled to reopen the prosecution as to those claims (Ae. A. 44a). Under such renewed prosecution he could have made a showing to the Patent Office by affidavit or by documents that the holding of the Board involved in Finding of Fact No. 8 is wrong. Having chosen not to do so, and having further chosen to present no evidence pertinent to this holding to the District Court, appellant cannot effectively complain of Finding of Fact No. 8.

Findings of Fact Nos. 9 and 10

As has been demonstrated in the discussion of Finding of Fact No. 4, Holmes discloses a method of determining the position of an unknown station relative to two, three, or four reference stations by phase comparison of a common modulation frequency, each reference station transmitting a carrier wave different from that of the others, and the unknown station including apparatus for simultaneously and separately receiving the modulation frequencies from any pair of reference stations and apparatus for simultaneously and automatically indicating the phase difference of the various received carrier waves.

As has been demonstrated in the discussion of Finding of Fact No. 5, Strobel discloses apparatus for increasing precision of distance measurements by phase comparison of modulation frequencies wherein the same series of different modulation frequencies is simultaneously impressed on each of the different carrier waves for two stations and continuous and simultaneous phase comparison is made for each modulation frequency with respect to the two stations.

Appellant has unconvincingly attacked the findings of continuous and simultaneous indication in each of the patents to Holmes and Strobel. As previously indicated, even if that attack had been effective, it would clearly have been irrelevant to all his claims except claims 62 and 64.

Appellant has also unconvincingly attacked Finding of Fact No. 6 that none of the claims at bar are limited to phase difference indicators distinguishable from those of Holmes or Strobel in degree of accuracy or of automatism. However, the specific phase comparison means of appellant's claims 62 and 64, even if it had been shown not to be suggested by the Holmes and Strobel patents, could not be critical since it is not set forth in other claims. *In re Ripper,* 36 C. C. P. A. 743, 171 F. 2d 297; *In re Fear,* 30 C. C. P. A. 1197, 136 F. 2d 908 (seventh paragraph from the end of the decision). (Note Ae. A. 47a.)

Appellant in his brief alleges (page 39, third full paragraph) that appellant's apparatus has been constructed and found successful in actual use. Whether such use was an experimental or test use in his shop or a commercial use in a vehicle is neither alleged nor proved. Appellant also alleges in his brief (page 8, lines 5 and 6) that the substance of the application at bar "is the heart of the Bomb Director System Mark 6 of the U. S. Navy." However, the only testimony adduced by appellant on this point is contradictory and to the effect that at the time of the trial, he did not know what the Government had done with the equipment he delivered to it (Ae. A. 48a). Appellant has adduced no evidence of any significant use or commercial success which might suggest presence of patentable invention despite the disclosures of the prior patents.

Appellant (brief, page 38) also attacks the prior patents of record as "paper patents." He has adduced no evidence to prove that their disclosures have never been practically used. Be that as it may, lack of patentable substance may be shown as well by "paper patents" as by patents which have been commercially exploited. *Western States Machinery Co.* v. *S. S. Hepworth Co., supra.*

Appellant notes (brief, page 37) that, in the past, combinations of old elements have been held patentable. The Board of Appeals specifically held that modification of Holmes in view of Strobel produces "no new or unobvious result" (Ae. A. 37a). Appellant has adduced no evidence that his combination of old elements functions to produce a new result which is more than the summation of the results of the prior functioning of those old elements. In the absence of such evidence patentable combination has not been shown. *Great Atlantic & Pacific Tea Co.* v. *Super-*

market Equipment Corp., 340 U. S. 147. (See Ae. A. 42a, line 34.)

It is submitted that there is a rational basis for the finding of the Board of Appeals (Ae. A. 31a, 40a) and of the District Court (Finding of Fact No. 9) that no patentable invention is involved in increasing the precision of the system of Holmes, with its simultaneous and continuous indication, for pairs of reference stations, of phase differences on a single frequency modulating different carrier waves for each reference station, by incorporating therein Strobel's multiple frequency modulation system which is also disclosed as having simultaneous and continuous indication.

It is further submitted that the findings of the Board of Appeals (Ae. A. 31a, 40a) and of the District Court (Finding of Fact No. 10) that all the claims fail to define patentable invention over the patent to Holmes in view of the patent to Strobel clearly have a rational basis in all the evidence.

Finding of Fact No. 11

The Board of Appeals held claims 33 and 37 unpatentable over the patent to Shanklin No. 2,144,203 in view of the patent to Strobel No. 2,248,727 (Ae. A. 37a *et seq.*). The Board's analysis of the Shanklin reference (Ae. A. 37a) is self-explanatory.

Appellant (at pages 13, 14, 15, 33, and 34 of his brief) makes various attacks on the use of the Shanklin patent as a reference, some of which are relevant to the subject matter of claims 33 and 37, and others of which are not.

Appellant states (brief, page 13, last two lines) that Shanklin has only one phase comparator and (brief, page 15, first paragraph) that Shanklin cannot make comparisons simultaneously or automatically. But at page 2, column 1, lines 16 through 19, the Shanklin patent expressly discloses the broad concept of simultaneous indication of phase difference by multiplication of indicating phase meters. An indicating phase meter is obviously automatic for the function of indicating phase comparisons. Whether it is automatic for more specific functions is irrelevant to the subject matter of claims 33 and 37 which set forth no more specific limitation than that the means or devices for phase comparison be automatic. There is no requirement in these claims that the comparison means provide automatic continuous and *simultaneous* indication for each pair of a *plurality* of pairs of stations. As previously noted, the limitations of these claims would be met by apparatus including phase meters which indicate automatically but which require manual switching to make successive comparisons for the various pairs of a plurality of stations. Thus appellant's argument is both inaccurate and irrelevant.

At page 14, lines 1 to 6 of his brief, appellant further states that it is unlikely that *at the date of Shanklin's patent* a comparator was available that could indicate over the described range without adjustment. Appellant adduced no evidence to support that allegation. Moreover, that allegation is irrelevant (1) because the only material question is whether a comparator such as called for by the claims at bar was available *at the time appellant made his development* and (2) because the claims at bar clearly do not exclude adjustment of the comparator.

The further attack on Shanklin as a reference, made in the first two full paragraphs of page 14 of appellant's brief, is best answered in the Board's own words (Ae. A. 38a):

> We consider the term "synchronous" used by Shanklin as suggesting to one skilled in the art that the modulating signal may be generated at a central point and transmitted by a wire line or radio link, as shown for example in Fig. 2 of Holmes or by generating the modulating signal at one of the transmitting stations, such as A, and transmitted by radio to a receiver at station B, as shown for example in Figure 5 of Holmes.

The further attacks on Shanklin (particularly in the third and fourth full paragraphs of page 14 of appellant's brief) are obviously irrelevant to the substance of appellant's claims 33 and 37, none of which are limited to mounting of the reference stations on trucks, or to mounting of the unknown station in an airplane; and none of which exclude the use of four stations (i. e., are definitely limited to the use of less than four stations).

The patent to Strobel has been previously analyzed.

Appellant adduced no evidence of a new result, in the sense of the test for patentable combination of old elements as defined in the *Great Atlantic & Pacific Tea Co.* case, *supra.*

It is submitted that the action of the Board of Appeals in holding claims 33 and 37 unpatentable over Shanklin in view of Strobel has a rational basis and that, in the absence of significant new evidence pertinent to the issue of patentability, the District Court reasonably found no error in that portion of the decision of the Board of Appeals.

CONCLUSION

All the claims on appeal, it is submitted, were properly refused to appellant on the ground that they define no invention over the prior art. Accordingly, it is further submitted that the judgment appealed from was correct and should be affirmed.

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Attorney for Appellee.

George C. Roeming,
Of Counsel.
December 1957.

U. S. GOVERNMENT PRINTING OFFICE: 1957

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Prior Patents:

Holmes.. 49a
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Shanklin.. 79a

EXCERPTS FROM APPELLANT'S APPLICATION, AS FILED

SPECIFICATION

* * *

My invention relates to a system for determining the position of an object such as an airplane, projectile, ship, or vehicle, whether moving or stationary, from a plurality of reference points. These reference points may be all stationary, or all moving, or some moving and some stationary. My invention can also be used for measuring with high accuracy and precision, the distance between any two points which singly or together may be either moving or fixed. The applications described all may use radio waves for transmission of intelligence from one point to another in space. However in some embodiments of the invention it is advantageous to use light waves in place of radio waves. It is also advantageous under certain conditions to use sound waves and other forms of radiated energy. Thus although examples of the system have been described using radio waves it should be understood that this was by way of example only and that the invention appertains to all types of radiated energy. Some representative applications of this invention are as follows:

1. The measurement of the distance between two fixed points, as for surveying. The invention makes possible a more accurate measurement than is attainable by conventional means and, because radio waves can be used for the measurement, it makes possible measurements under conditions of impaired visibility (i. e. in fog or rain or at night, etc.). It makes possible the very accurate measurement of

distances without the use of tapes and hence renders it unnecessary that users of the equipment traverse the space between the two points whose space is being measured. Therefore the equipment can be used for the measurement of distances between mountain tops, distances across water, etc.

2. The continuous determination of the position of an aircraft, projectile, vehicle, ship, or other fixed or moving object from a plurality of reference points. For example, the position of an aircraft can be continuously and very accurately determined from a plurality of ground stations. Therefore this system is of great value for aerial mapping or for determining the flight path of an aircraft or other airborne object for testing purposes.

3. The automatic giving of directions to the pilot or other occupant of an aircraft for keeping the aircraft on a predetermined course. Hence it is applicable to aerial navigation, blind flying, and blind landing.

4. The direction of the path in space of a piloted or an unpiloted aircraft, bomb, vehicle, ship, or other object so as to cause it to move along a predetermined or controlled path.

The methods and apparatus for performing such functions include the following illustrative examples, which are better described in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagram used to illustrate the principle of the determination of a distance difference by a phase comparison measurement;

Fig. 2 is a diagrammatic illustration of an apparatus for determining the distance between two points;

Fig. 3 is a diagrammatic illustration of an apparatus arrangement for obtaining the position of a body with respect to a plurality of reference points;

Fig. 4 is a diagrammatic representation of a variational arrangement of the apparatus illustrated in Fig. 3;

Fig. 5 is a diagrammatic illustration of an apparatus for determining the position of a fixed or moving object relative to a plurality of reference points;

Fig. 6 is a diagrammatic representation of a possible arrangement of the apparatus illustrated in Fig. 5;

Fig. 7 is a diagrammatic illustration of an apparatus for the visual or photographic indication of a phase difference;

Fig. 8 is a diagrammatic illustration of an apparatus for navigating a moving object relative to a plurality of fixed objects;

Fig. 9 is a diagrammatic illustration of an apparatus for controlling the direction of motion and course of a moving object relative to a plurality of fixed reference points; and

Fig. 10 is a diagrammatic illustration of another apparatus arrangement for determining the position of a fixed or moving object relative to the locations of a plurality of reference points.

In Fig. 1, let T represent a radio transmitter and let points R_1 and R_2 represent radio receivers located at equal distances from the transmitter. The radio waves travelling from the transmitter to the receivers are represented by the dashed lines in Fig. 1. It will be seen that the radio waves received at stations R_1 and R_2 will always be in phase because the two receiving stations are equal distances from the transmitter. However, if receiving stations R_1 and R_3, which are unequal distances from the transmitter T, are considered, it will be seen that if a comparison is made between the phase of the radio waves received at R_1 and R_3, a difference in phase will be observed. It can be seen from Fig. 1 that a knowledge of the wave lengths used and the difference in phase between the signals received at R_1 and R_3 may not be sufficient to determine the distance difference Q–R because if the distance S between station R_3 and some other station R_4 is equal to one wave length, the phase difference between R_1 and R_3 is equal to the phase difference between R_1 and R_4. However, now let it be assumed that the radio carrier wave emitted from transmitter T has a constant modulation frequency superimposed on it. A phase comparison can now be made at receiving stations R_1 and R_3, for example, of the difference in phase between the modulation signals received at these two receiving stations. If the wave length of the modulation frequency has been chosen equal to twice the distance from the transmitter to receiver R_1, a phase difference of no more than 180° can exist when the signals received at R_1 and R_3 are compared, and this holds true for any location of receiving station R_3 in which its distance from transmitter T does not exceed the distance of receiving station R_1 from transmitter T. It can therefore be seen that if the modulation wave length is made sufficiently long, the difference between the distances of the two receivers from the transmitter can be determined without ambiguity. However, let it be assumed that the amount of phase shift (in degrees) that can be detected is approximately independent of frequency. Now assume that in addition to the above mentioned modulation frequency N_1 there is applied to the carrier wave a second modulation frequency N_2 of much shorter wave length. Assume that a phase comparison can be made to the same degree of accuracy at this modulation frequency as was possible at frequency N_1. Then this modulation frequency serves to determine the difference between the distances of the two receivers from the transmitter with an increase in accuracy of N_2/N_1. If further accuracy is desired, more modulation frequencies can be employed.

As an example of the above, let it be assumed that the distance between T and R_1 is 100 miles, and let it further be assumed that the difference in phase between R_1 and R_3 can be measured with an accuracy of 2 degrees. Suppose the wave length of the modulation frequency N_1 is chosen as 200 miles. If the phase comparison at this modulation frequency is made to within 2 degrees, the distance difference Q—R can at least be determined with an accuracy of $\frac{2}{180} \times 100$ or 1.11 miles. Now suppose the next modulation frequency N_2 has a wave length of 20 miles. Then a phase comparison accurate to two degrees at this wave length will measure the distance difference Q—R to within 0.11 miles, or 581 ft. If now a third modulation having a wave length of 2 miles is used, a phase comparison accurate to 2 degrees at this wave length will determine the distance difference Q—R to 58 ft. The use of a fourth modulation wave length of 0.2 miles similarly makes possible the determination of the distance difference with an accuracy of 5.8 ft., and the use of a fifth modulation wave length of 0.02 miles makes possible a determination of the distance difference to 0.58 ft. Hence with the use of these five modulation wave lengths it is possible to determine the distance difference over a range of 100 miles without ambiguity with an accuracy of 0.58 ft.

The technique outlined above can be applied directly to the measurement of the distance between two points in the following manner. In Fig. 2, let A represent the equipment located at one of these points, and B the equipment at the other. Modulation frequency generator 1 at station A is a device for producing the wave modulation frequencies. This can consist of a system of vacuum tube oscillators, or a piezoelectric crystal-controlled oscillator and appropriate dividing circuits, or any other type of frequency generating device, many of which are well known to the art. The various modulation frequencies are used to modulate the output of transmitter 3 via the modulator 2. The modulated signal is transmitted by antenna 4 to receiving antenna 5 at station B. The frequency of the carrier wave used for this transmission will be called f_1. At station B, the signal picked up by antenna 5 and receiver 6 is demodulated by detector 7, that is, the input to detector 7 is a modulated carrier wave; its output consists merely of the modulation frequencies. These modulation frequencies modulate the output of transmitter 9 via modulator 8. They are transmitted by transmitter 9 and antenna 10 and are received by antenna 11 at station A. The frequency of the carrier used for this transmission is f_2, and this frequency will generally differ from the frequency of f_1 mentioned above. The signal received by antenna 11 and receiver 12 passes through detector 13 which demodulates the carrier. The output of detector 13 consists solely of the modulation frequencies. This output passes into the filters 14. There is a filter at this point in the circuit for each modulation frequency. The sole output of each filter is the modulation frequency to which it is tuned. Each frequency is now compared, with regard to phase with the corresponding modulation frequency from the generator 1. If all the equipment in the system has been so designed that no phase shifts occur within any of the components, the difference in phase which can now be determined at each modulation frequency is contributed solely by the transmission from station A to station B, and back to A. Hence this phase comparison enables one to determine a number equal to twice the distance between A and B, and from this the distance between A and B is readily deduced.

The position of a stationary or moving object can be determined relative to the positions of a plurality of reference points by placing a plurality of equipments of the type shown as B in Fig. 2 at the point whose position is to be determined, and placing corresponding equipment of the type designated A in Fig. 2 at each of the reference points. This will enable the distance to each of the reference points from the point whose position is to be determined to be measured as described above. From a knowledge of these distances the location of the point whose position is to be determined can be computed relative to the positions of the reference points. This is illustrated in Fig. 3.

The position of a stationary or moving object can be determined relative to the positions of a plurality of reference points by placing a plurality of equipments of the type shown as A in Fig. 2 at the point whose position is to be determined, and placing corresponding equipment of the type designated B in Fig. 2 at each of the reference points. This will enable the distance to each of the reference points from the point whose position is to be determined to be measured as described above. From a knowledge of these distances the location of the point whose position is to be determined can be computed relative to the positions of the reference points. This is illustrated in Fig. 4.

If the apparatus illustrated in Figs. 2, 3, and 4 is not completely free of phase shift, the difference in phase that will be found between the signals from modulation frequency generator 1 and those that have been transmitted to station B and back to A will have been caused in part by the phase shift inherent in some of the circuit elements. When this is the case, stations A and B can be set a known distance apart and a phase comparison made at each modulation frequency. The phase shift that is due to the known distance between the stations can be subtracted from the total observed phase shift; the residue may be considered a constant error for the equipment and may be subtracted from readings obtained when the equipment is placed in practical use.

A representative means for making a comparison of phase at each modulation frequency will be described below.

The general type of equipment described above, and illustrated in Figs. 2, 3, and 4 may be used to determine continuously the position of a given point, which may be moving or fixed, relative to three or more reference points. For example, the position of an aircraft relative to a plurality of fixed stations on the ground may be determined continuously by having, in the aircraft, apparatus of the type illustrated as B in Fig. 2. At least three such pieces of equipment must be located in the aircraft, and the receiving and transmitting frequencies of these pieces of equipment will all be different. There must be one or more ground stations tuned to the transmitting and receiving frequencies of each of the airborne pieces of equipment. For example, there could be three airborne equipments and three ground stations, each airborne equipment and ground station having its own exclusive pair of frequencies for transmitting and receiving. Using the procedure described previously in connection with Fig. 2, the distance from the aircraft to each of the ground stations can thus be continuously determined. These distances can be recorded continuously at each ground station, or recordings can all be made at a single ground station. If the distance from the aircraft to each of three or more ground stations is known continuously, the position of the aircraft can obviously be determined continuously by conventional trigonometric computation from a knowledge of these distances, as is well known to the art. * * *

The apparatus for making the comparison of phase between the signals received with receivers 506 and 521 at station D has been omitted from the drawing for the sake of clarity, but is similar to that used for the comparison of the signals received at receivers 506 and 517. Similarly, the equipment for the comparison of phase between the signals received by receivers 517 and 521 has been omitted for clarity and simplicity. This is also similar to that used for the comparison of signals received by receivers 506 and 517.

In Fig. 6 let C represent the aircraft which contains the apparatus shown at C in Fig. 5. Similarly, let D, E, and G represent three possible ground stations, and assume each of these ground stations contains apparatus of the type indicated by the corresponding letter in Fig. 5. The comparison of the phase of the signals received by receivers 506 and 517 in Fig. 5 gives, as has been indicated above, the difference between distances g and e in Fig. 6. Hence from this phase comparison is known the distance difference g–e. Similarly, the comparison of the phase of the signals received by receivers 506 and 521 of Fig. 5 gives the distance difference g–f in Fig. 6. And, similarly, the comparison of phase of the signals received by receivers 517 and 521 of Fig. 5 gives the distance difference f–e in Fig 6.

* * * it is necessary to have a means for comparing the phases of two wave motions. Many methods for accomplishing this are known to the art. A special method of making this phase comparison will be described.

Assume that a phase comparison is to be made of two signals of the same frequency which differ in phase. Let the phase angle of one of these signals be x and that of the other signal be y. As shown in Figure 7, let the signal of phase angle x be fed into a conventional phase splitting network such as 701 in Fig 7. The outputs of this phase splitter are two signals having a phase difference of 90°. Both of the otuput signals will differ in phase from the input signal by a constant amount Z_1 which represents the constant phase shift introduced by the phase splitter. The two output signals of the phase splitter 701, which differ in phase by 90°, are fed to two adjacent deflector plates 703 and 704 of a cathode ray oscilloscope tube 707. Because these two signals differ in phase by 90°, they will cause a circle to be traced on the face of the oscilloscope tube.

In a similar fashion, the signal of phase angle y is fed to a phase splitter 702 whose output also consists of two signals which differ in phase by 90°. Phase splitter 702 also introduces a constant phase shift Z_2 to both output signals. These two signals are fed to the other two adjacent plates 705 and 706 of the cathode ray oscilloscope. In the absence of a signal on plates 703 and 704, the signals on the plates 705 and 706 then cause the cathode ray beam to trace a circle on the face of the oscilloscope tube. By properly connecting the outputs of phase splitter 702 to plates 705 and 706, the circle traced on the oscilloscope tube can be caused to rotate in the opposite sense from the circle generated by the signals on plates 703 and 704. When signals are applied to all four oscilloscope deflector plates, the two circular signals combine to produce a straight line on the face of the oscilloscope tube. The angle between this line and any reference line on the face of the oscilloscope is directly proportional to the phase difference x–y which it is desired to determine. By rotation of the cathode ray oscilloscope tube about its longitudinal axis of symmetry it is possible to cause the line traced on the oscilloscope face to be at any desired inclination to a reference line for a known phase shift. Hence the rotation of the oscilloscope tube about its axis of symmetry may be used to set the zero of the phase comparison system.

With equipments of the type suggested in Figs. 2 and 5, an oscilloscopic phase comparator and indicator of the type described above can be used for the comparison of phase at each modulation frequency. Hence if five modulation frequencies are used in the distance measuring equipment shown in Fig. 2, five such phase comparators are used to determine the total phase difference. If five modulation frequencies are used with the position determining equipment illustrated in Fig. 5, five oscilloscopic phase comparators are used for the comparison of the signals received with receivers 506 and 517, five for the comparison of the signals received with receivers 506 and 521, and five for the comparison of the signals received with receivers 517 and 521. Therefore if five modulation frequencies are used, a total of fifteen oscilloscopic phase comparators is required.

The phase comparison information indicated on the faces of the oscilloscopes used in the phase comparators can be read by an observer and recorded by him, or can be recorded photographically. In photographic recording, pictures may be taken intermittently with a conventional motion picture or still camera, or a shutterless camera with continuously moving film may be employed. In this latter case, the brightness of the image on the face of each oscilloscope can be intensified momentarily by application of a voltage to a control electrode whenever it is desired to obtain a picture. * * *

Another method for applying my invention to the determination of the position of a radio station relative to the locations of a plurality of reference stations is shown in Fig. 10. One of the reference stations is designated L. At this station, a plurality of modulation frequencies is generated at modulation frequency generator 1001. These modulation frequencies are impressed, with modulators 1002 and 1003, on the carrier frequencies generated in transmitters 1004 and 1005. The modulated carrier waves are sent out with antennas 1006 and 1007. Transmitter 1005 sends out a wave of carrier frequency f_6, and this wave is received by antennas 1008 and 1009 and receivers 1010 and 1011 of reference stations M and N respectively. The signals received by receiver 1010 are demodulated in detector 1021 and are used to modulate the carrier frequency generated in transmitter 1013 by modulator 1012. In a similar fashion the signals received by receiver 1011 at reference station N are demodulated in detector 1014 and are impressed on a carrier of different frequency by modulator 1015 and transmitter 1016. The carrier frequencies of transmitters 1013 and 1016 are different from each other, and are both different from the carrier frequency of transmitter 1005. Station P whose position is to be determined receives modulated carrier waves directly from transmitter 1004, and also retransmitted modulated carrier waves from transmitters 1016 and 1013 of station N and M. Receiver 1017 at station P receives the modulated carrier directly from transmitter 1004 at station L. Receiver 1018 at station P receives a retransmitted signal from transmitter 1013 at station M, and receiver 1019 at station P receives a retransmitted signal from transmitter 1016 at station N. The outputs of receivers 1017, 1018, and 1019 at station P are all demodulated by detectors, and the various modulation frequencies in the outputs of each detector are separated by filters. At phase comparator 1020 the various modulation frequencies from the outputs of receivers 1018 and 1019 are compared as to phase. Similarly comparators, which are omitted from the illustration for the sake of simplicity, are used to compare the phases of the modulations in the outputs of receivers 1017 and 1019, and 1018 and 1017.

The information obtained from the phase comparisons mentioned in the preceding paragraph can be used in the manner described previously, to determine the location of station P relative to stations L, M, and N.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A device for accurately determining the distance between two stations comprising, at the first station, equipment for generating a plurality of modulation frequencies, a carrier wave generator, an emitter, and equipment for impressing said modulation frequencies on said carrier wave, also a receiver, detector, equipment for separating the separate modulation frequencies on the received signals, and equipment for comparing the phase, at each modulation frequency, of the modulation of the emitted signal with that of

the received signal, and also comprising, at the second station, means for receiving said carrier wave and demodulating same, equipment for impressing the modulation frequencies so obtained on a second carrier wave, and means for transmitting the said second carrier wave.

* * * * *

4. A method for determining the distance between two points comprising, transmitting a carrier wave, modulating this carrier wave with a plurality of modulation frequencies, receiving the carrier wave, separating the different modulations in the received carrier wave, and comparing the phase of each modulation of the transmitted carrier wave with that of the received carrier wave, and also receiving the carrier wave at a second station and retransmitting it to the first named receiving means.

* * * * *

15. A device for determining the location of a station relative to a plurality of reference stations, one or more of the reference stations comprising a device for generating a plurality of modulation frequencies, one or more carrier wave generators, and equipment for modulating said carrier waves; other reference stations each comprising a receiver, a detector, a carrier wave generator, and means for modulating said carrier wave; the station whose position is to be determined comprising receivers for each carrier wave frequency to be received at that station, detectors for each receiver, equipment for the output of each receiver to separate the modulation frequencies of the carrier received by that receiver, and devices for comparing the phase of the modulations of the various received carrier waves in pairs.

* * * * *

APPELLANT'S APPLICATION

Drawings As Filed.

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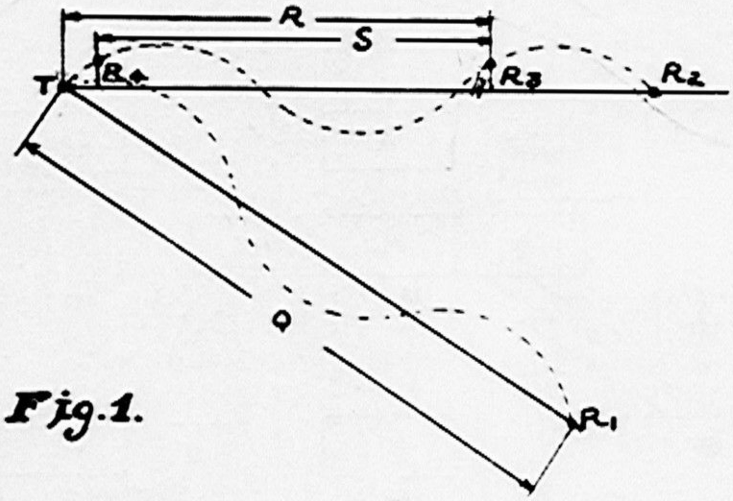

Fig.1.

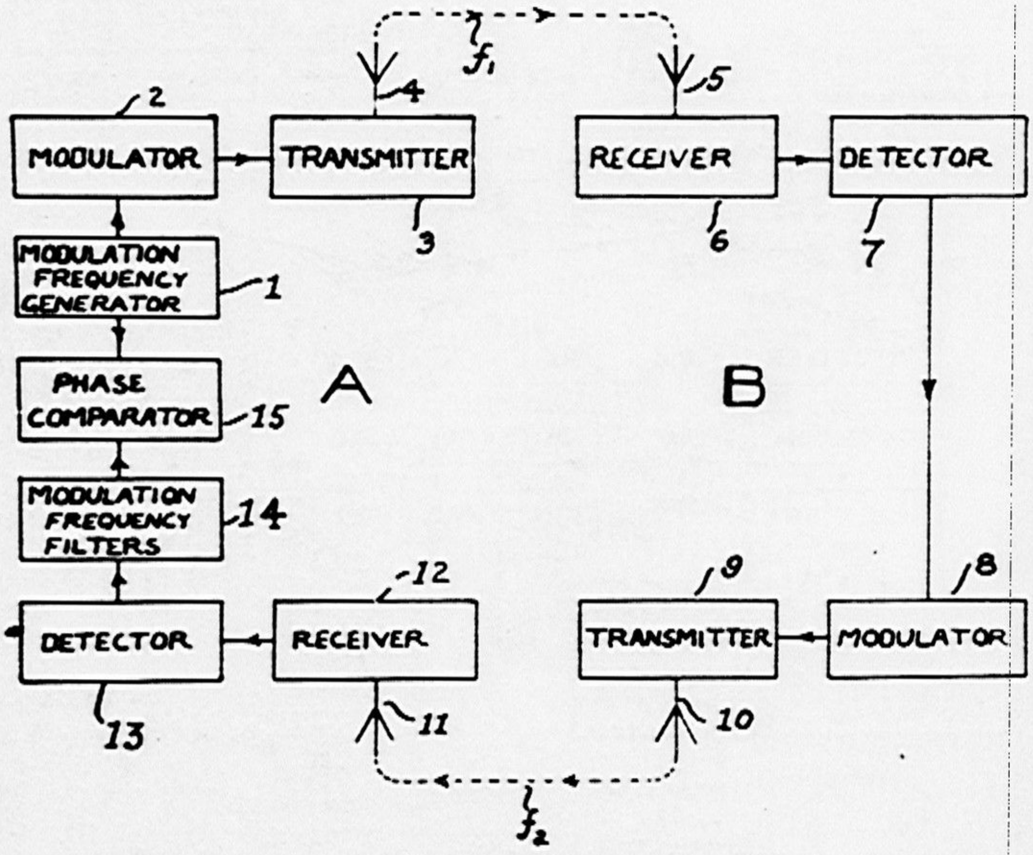

Fig.2.

INVENTOR
Donald H. Jacobs

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Fig. 3.

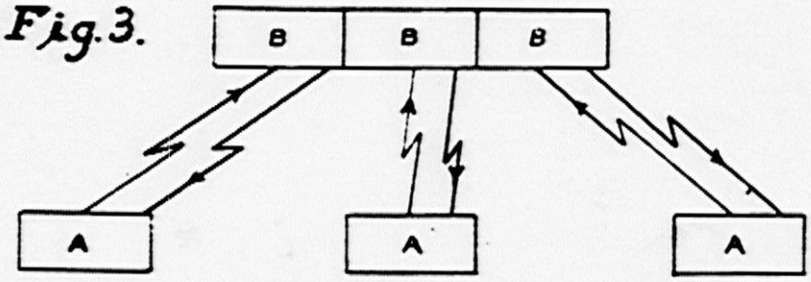


Fig. 4.

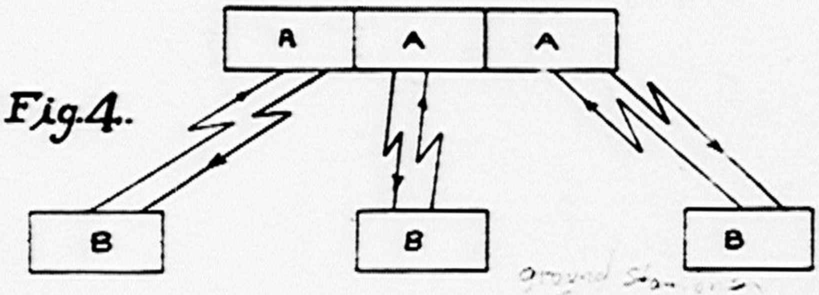
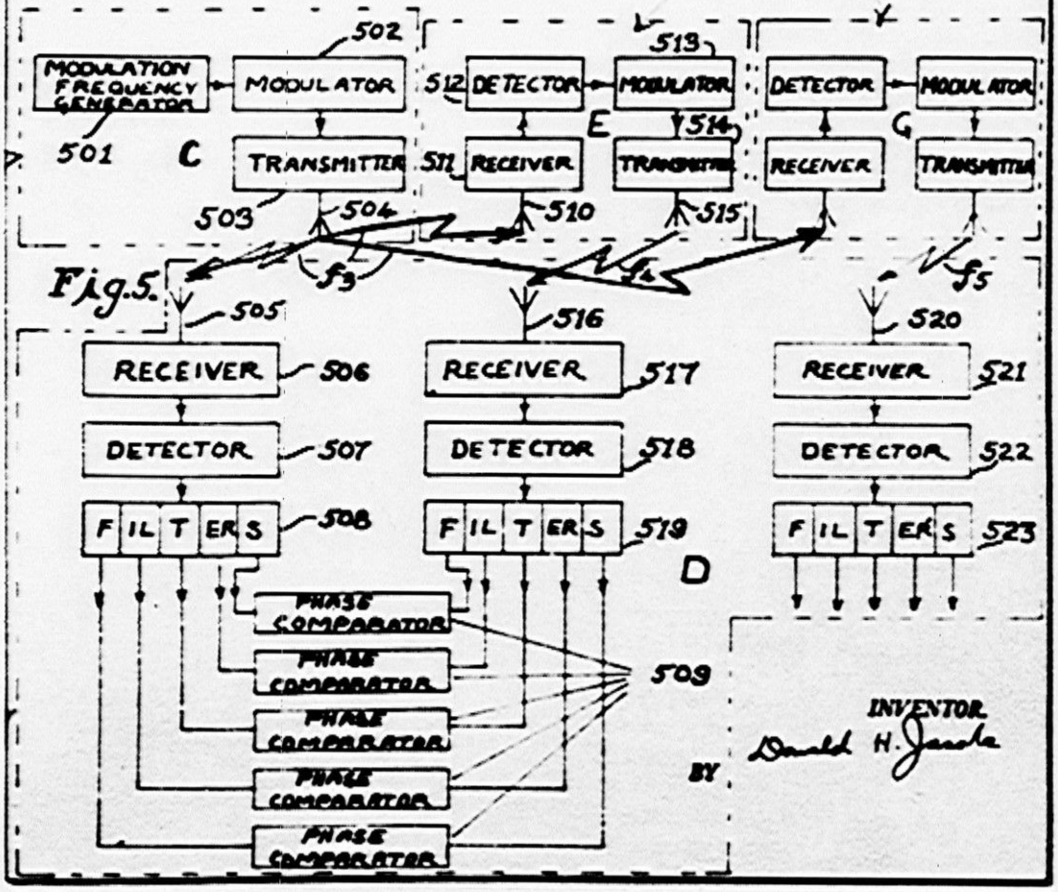


Fig. 5.



INVENTOR
Donald H. [illegible]
BY

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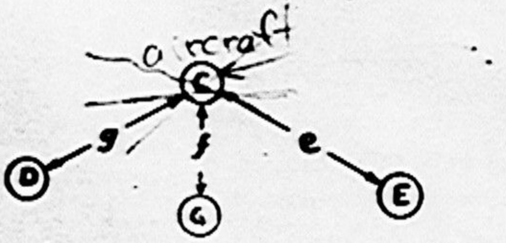

Fig.6.

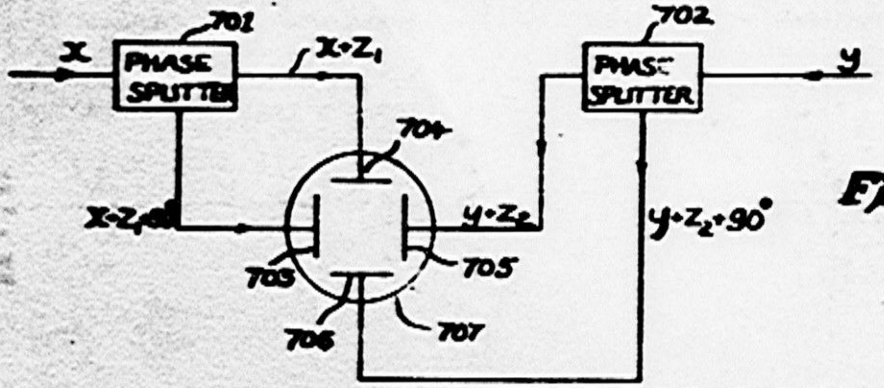

Fig.7.

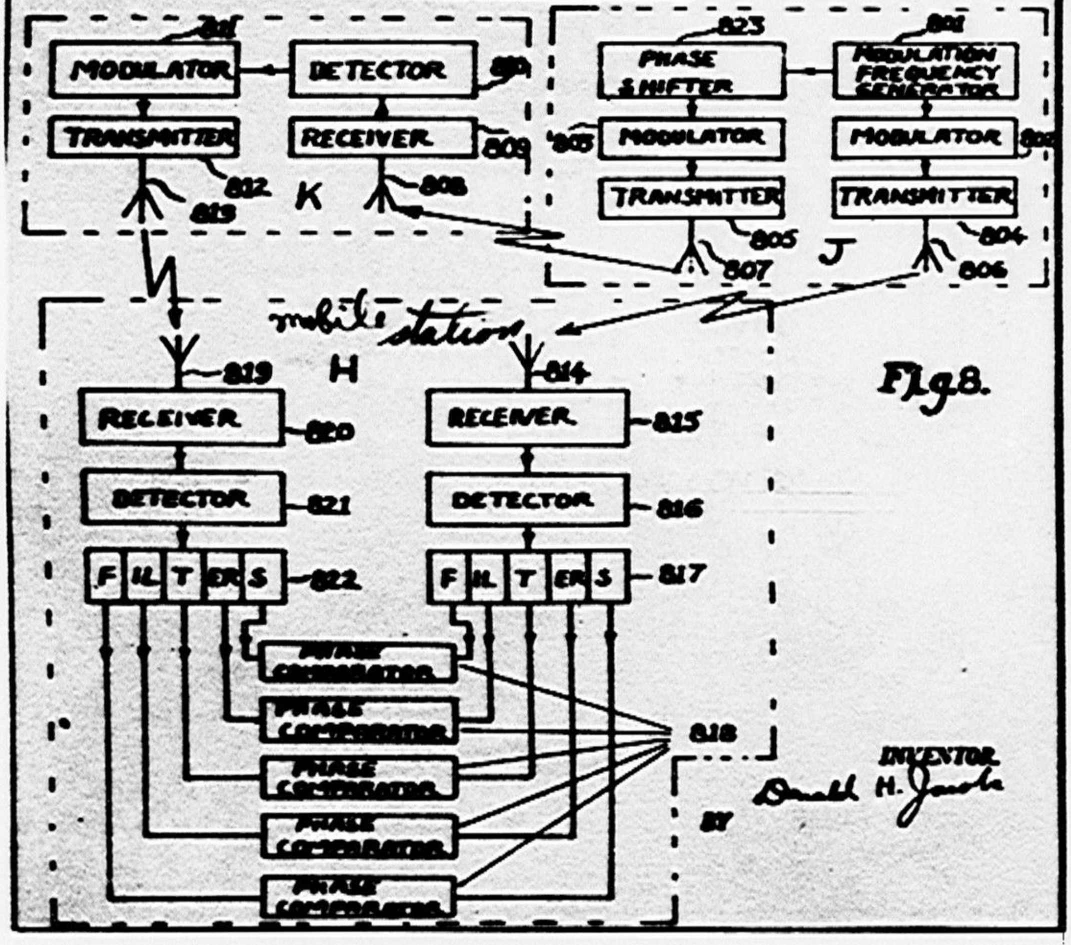

Fig.8.

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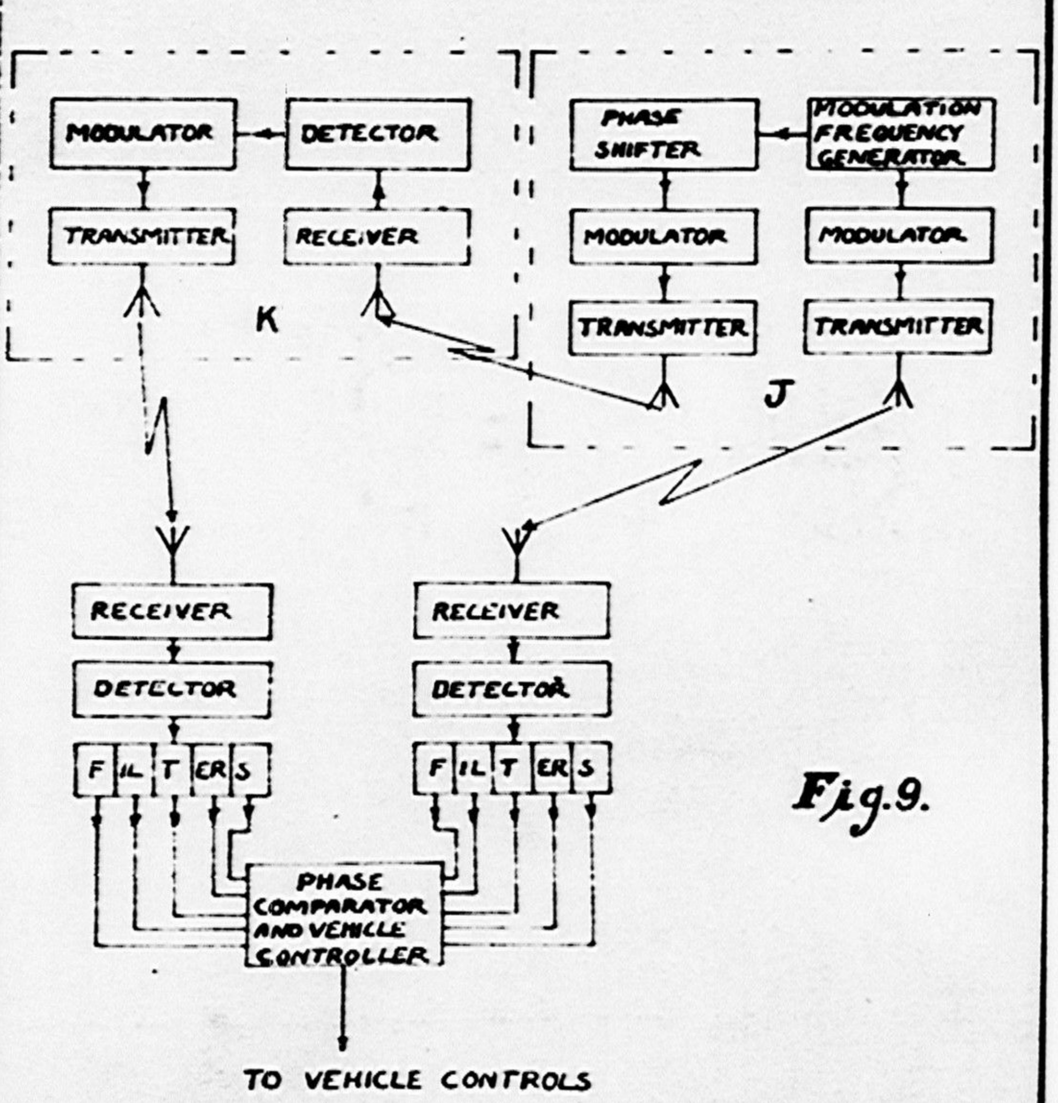

Fig. 9.

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BY Donald H Jacobs

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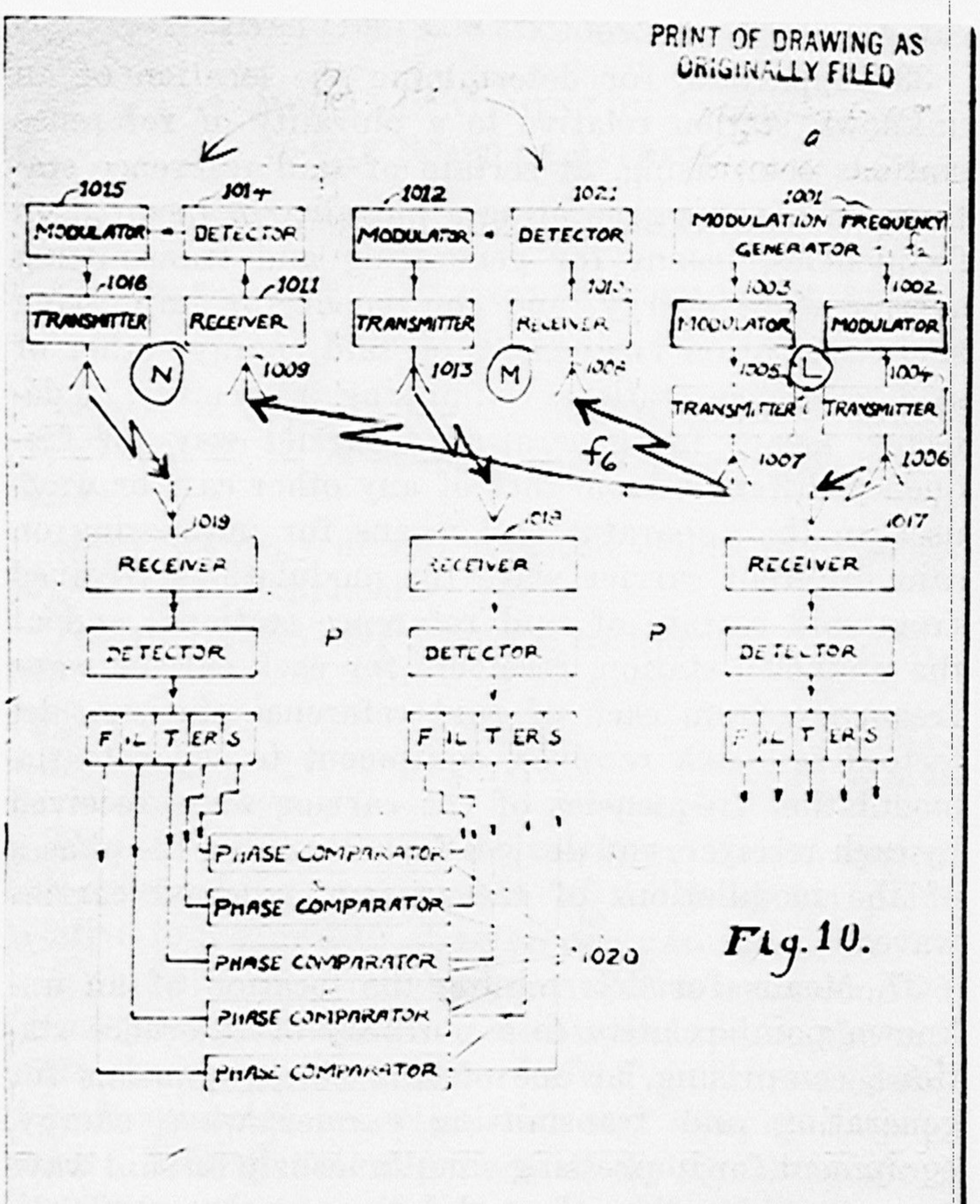


Fig. 10.

INVENTOR
Donald H. Jacobs
BY

Claims 33 and 37 as filed (in the amendment of January 26, 1950, paper No. 6, of appellant's application):

33. Apparatus for determining the location of an unknown station relative to a plurality of reference stations comprising, at certain of said reference stations, means for generating a plurality of modulation frequencies, means for generating and transmitting carrier wave energy, and equipment for impressing said modulation frequencies on said energy; other of said reference stations comprising a receiver, a detector, means for generating a carrier wave of frequency different from that of any other carrier wave used in the apparatus and means for impressing on said different carrier wave the modulations received from said certain of said reference stations; and at the unknown station, receivers for each carrier wave frequency from each of said reference stations, detectors for each receiver, equipment to separate the modulation frequencies of the carrier wave received by each receiver, and devices for comparing the phases of the modulations of the various received carrier waves.

37. Means for determining the location of an unknown point relative to a plurality of reference stations, comprising, at one of said stations, means for generating and transmitting carrier wave energy, equipment for impressing simultaneously on said wave energy a plurality of modulations arranged in diminishing series; other of said stations comprising receiver for said modulated energy, together with means for generating and transmitting other wave energy of frequency different from that of any other station and for impressing on said other wave energy the modulations received from said one station; there being at the unknown point receivers for the wave

energy from each station and means for comparing the phase of the modulations of the various wave energies received from said stations.

EXAMINER'S STATEMENT ON APPEAL TO THE BOARD OF APPEALS

(Mailed April 23, 1952, by Division 70)

PAPER NO. 22. IN RE APPLICATION OF DONALD H. JACOBS,
SERIAL NO. 60,731

This is an appeal from the final rejection of claims 33, 37 and 60 to 64 being all the claims in the application.

A correct copy of the appealed claims appears on pages 1 to 4 of applicant's brief.

The references relied on are as follows:

Shanklin	2,144,203	Jan. 17, 1939
Holmes	2,198,113	Apr. 23, 1940
Strobel	2,248,727	July 8, 1941
Nosker	2,470,787	Mar. 24, 1949

This invention relates to a radio navigation system for determining the location of an unknown point relative to a plurality of reference stations.

A plurality of modulation frequencies is transmitted from spaced reference radio stations; and on the aircraft the radio waves are received and the modulation frequencies are recovered and compared as to phase. This phase comparison of the signals received from the reference stations, gives an indication of position.

Applicant has elected for prosecution in this application the invention disclosed in his Figure 10.

Figure 10 shows a plurality of reference stations L, M and N by means of which the location of receiver station P is to be determined.

One of the reference stations L generates a plurality of modulation frequencies in modulation generator 1001 which are modulated in modulator 1002 upon transmitter 1004 and radiated at antenna 1006. This radio wave is received by receiver 1017 at station P.

Modulation frequencies in generator 1001 are also modulated upon transmitter 1005 by modulator 1003 and this signal is radiated by antenna 1007.

The radio wave from 1007 is received at reference station M on antenna 1008 connected to receiver 1010 and detector 1021 where the modulation frequencies are derived and applied to modulator 1012 and modulated on transmitter 1013.

The radio wave from 1013 is received on receiver 1018 at station P.

The radio wave from antenna 1007 in reference station L is also received on antenna 1009 at reference station N and by receiver 1011 and detector 1014 the modulation signals are recovered and applied to modulator 1015 for modulation on transmitter 1016 and radiation, and for reception by receiver 1019 in station P.

At station P each of the receivers are connected to detectors and filters for separating the various modulation frequencies, and comparing of the phase thereof is made in phase comparator 1020. This enables the position of station P with respect to reference stations L, M and N to be made.

The patent to Nosker shows in Figure 4 control station S1 comprising signal generator 11, transmitter 13, and antenna 14, also receivers 21a, 21b, and 21 connected to one side of phase meters 25a, 25b and 25. The other side of each of the phase meters is connected to signal generator 11. Each of the observation stations S2 and S3 and the airplane station contains a receiver for receiving the radio wave from transmitter 13, and deriving the modulation, and a transmitter for retransmitting a radio wave with the same modulation thereon to one of the receivers at control station S1.

Thus the comparison of phase of the modulation signals received at S1 enables a determination to be made of the relative location of station S1 with respect to Stations S2, S3 and the airplane station.

The patent to Strobel shows in Figure 5 a radio signalling system wherein a *plurality* of modulation frequencies are utilized for greater accuracy. Two modulation frequencies are generated in OSC.fm1 and OSC.fm2 and modulated upon the carrier wave from OSC.fca in the modulator (mod. fca:fm), and after amplifying in R. F. Amp at a primary station are radiated. At the remote or secondary station the radio wave is received and detected to derive the modulation frequencies and these modulation frequencies are modulated upon a different carrier (OSC. fcb) and radiated back to the primary station. At the primary station the radio wave is received and the modulation frequencies are recovered and compared in phase with the original modulation frequencies, to give an indication representing the distance between the primary station and the secondary station.

The patent to Holmes shows in Figure 4 a modulation source 35a providing a signal to transmitter and modulator 35b for radiation on antenna 35c. This signal is received on each of receivers 36a, 37a and 38a and is modulated upon each of transmitters 36b, 37b and 38b for radiation by antennas 36c, 37c and 38c, respectively. On the mobile receiving equipment the various signals are received and a comparison of phase of the modulation signal received from the reference stations is made to provide an indication of the location of the mobile receiver.

Claims 33 and 37 have been finally rejected as unpatentable over Nosker in view of Strobel, on the ground that it would not require invention to modify the system of Nosker to generate simultaneously a plurality of modulation of frequencies as taught by Strobel.

Claim 33, for example, is considered readable upon Nosker in view of Strobel in the following manner: Nosker shows a means determine the location of an unknown station (Airplane station shown in Figure 4) relative to a plurality of reference stations (S1, S2, S3) comprising at reference stations S1 means (11) for generating a modulation frequency, means (13) for generating and transmitting carrier wave energy, and equipment (13) for impressing said modulation frequency on said energy, other of said reference stations (S2 and S3) comprising a receiver, (15b, 15a) a detector and means (18b, 18a) for generating a carrier wave of frequency different from that of any other carrier wave used in the apparatus and means (18b and 18a) for impressing on said different carrier wave the modulation received from said one (S1) of said reference stations. Nosker provides at control station S1 receivers (21, 21a, 21b) for each carrier wave frequency from each of said reference stations S2, S3 comprising suitable detectors and equipment to separate the modulation frequencies of the carrier wave received by each receiver and devices (25, 25a, 25b) for comparing the phases of the modulations of the various received carrier waves. The claim recites that the receivers and phase comparing means is "at the unknown station" and in the showing of Figure 4 of Nosker this requires receivers and phase comparison means on the airplane station, but no patentability is seen, however, in providing receivers 21, 21a and 21b and phase meters M of control station S1 of Nosker upon his airplane station. Particularly is this so in view of Figure 5 of Strobel, wherein the primary station on the airplane is provided with a suitable receiver, detector, filters fm1 and fm2 and phase determining means. While Nosker uses a *single* modulation frequency generated by signal generator 11, no invention is seen in utilizing a *plurality* of modulation frequencies as shown to be old by Strobel.

Claim 37 is considered readable upon the same references and for the same reasons as claim 33.

Claims 60 to 64, proposed after the final rejection of August 17, 1951, have been entered for purposes of appeal. These claims are considered to be unpatentable over Nosker (Figure 4) or Holmes (Figure 4–6) in view of Strobel.

The manner in which claims 60 to 64 are readable upon Nosker in view of Strobel is the same as above pointed out against claim 33.

Claim 60 is considered readable upon Holmes (Figure 4–6) in view of Strobel in the following manner: Holmes shows a device for determining the location of a station (movable aircraft 41) relative to a plurality of reference stations 35, 36, 37 and 38. One of the reference stations comprising means (35a) for generating a modulation frequency, means (35b) for generating carrier wave energy and for modulating the carrier wave energy with the modulation frequency, other reference stations (36, 37, 38) each comprising a receiver for said modulated energy, a detector, a generator of different carrier wave energy, means for modulating said different carrier wave energy with the modulation frequency and means for transmitting said modulated energy. The station whose position is to be determined comprises receivers for each carrier wave (41a) comprising detectors for each receiver, and phase comparison means (41b) for comparing the phase modulations of the received carrier wave energy in pairs.

Thus, it is seen that every element recited in the claim is met by Holmes except that Holmes uses only *one* modulation frequency. But no invention is seen in merely using a *"plurality"* of modulation frequencies in the same manner and for the same purpose as shown by Strobel. Strobel explains how distances up to one half the modulation wave length can be measured without ambiguity and that greater precision of the measurement can be obtained by using a higher frequencies of modulation.

Applicant argues in his brief that the "single receiver" 41a shown in Figure 4 of Holmes "cannot be constructed to receive two different carrier waves simultaneously and provide means for comparing the phase of the same modulation frequency carried by the two different waves."

But Holmes states (page 5 right column lines 70 to 75, and page 6 left column lines 1 to 3) that "receiving equipment 41 which may be carried on an airplane is shown as comprising a radio receiver 41a which is capable of receiving the modulated carrier waves from either pair of stations 35 and 36, or 37 and 38, and which further includes a phase angle indicator 41b that will produce a perceptible indication which will vary in accordance with the phase difference between the modulation of the carriers so received."

It appears quite obvious that Holmes considers his "receiving equipment 41" to be old, and the patent to Shanklin is cited to show that such "receiving equipment" is conventional and well known. Shanklin shows in Figures 2 and 3, a receiver comprising antenna 12 connected by receivers 10 and 11, filters 15, 16, 17 and frequency selecting means 18 and 19 to phase meter 14. Thus while Holmes may not show a plurality of receivers, it is well known that his "receiving equipment 41" will include a plurality of receivers as shown by Shanklin.

For the above reasons the Final Rejection is considered properly made.

James L. Brewrink,
Examiner

CLJ:wgc

Decision of Board of Appeals

(Mailed November 30, 1954)

PAPER NO. 31. EX PARTE DONALD H. JACOBS

This is an appeal from the Examiner's rejection of claims 33, 37 and 60 to 64. There are no allowed claims in the application.

Claim 33 is representative:

33. Apparatus for determining the location of an unknown station relative to a plurality of reference stations comprising, at one of said reference stations, means for generating a plurality of modulation frequencies, means for generating and transmitting carrier wave energy, and equipment for impressing said modulation frequencies simultaneously on said energy; other of said reference stations comprising a receiver, a detector, means for generating a carrier wave of frequency different from that of any other carrier wave used in the apparatus and means for simultaneously impressing on said different carrier wave the modulations received from said one of said reference stations; and at the unknown station, receivers for each carrier wave frequency from each of said refer-

ence stations, detectors for each receiver, equipment to separate the modulation frequencies of the carrier wave received by each receiver, and devices for automatically comparing the phases of the modulations of the various received carrier waves.

The references relied upon are:

Shanklin	2,144,203	Jan. 17, 1939
Holmes	2,198,113	Apr. 23, 1940
Strobel	2,248,727	July 8, 1941
Nosker	2,470,787	Mar. 24, 1949

The rejected claims relate to a system for determining the location of an unknown point relative to a plurality of reference stations. Appellant describes the elected modification of his invention in the following terms:

> Another method for applying my invention to the determination of the position of a radio station relative to the locations of a plurality of reference stations is shown in Fig. 10. One of the reference stations is designated L. At this station, a plurality of modulation frequencies is generated at modulation frequency generator 1001. These modulation frequencies are impressed, with modulators 1002 and 1003, on the carrier frequencies generated in transmitters 1004 and 1005. The modulated carrier waves are sent out with antennas 1006 and 1007. Transmitter 1005 sends out a wave of carrier frequency f_6, and this wave is received by antennas 1008 and 1009 and receivers 1010 and 1011 of reference stations M and N respectively. The signals received by receiver 1010 are demodulated in detector 1021 and are used to modulate the carrier frequency generated in transmitter 1013 by modulator 1012. In a similar fashion the signals received by re-

> ceiver 1011 at reference station N are demodulated in detector 1014 and are impressed on a carrier of different frequency by modulator 1015 and transmitter 1016. The carrier frequencies of transmitters 1013 and 1016 are different from each other, and are both different from the carrier frequency of transmitter 1005. Station P whose position is to be determined receives modulated carrier waves directly from transmitter 1004, and also retransmitted modulated carrier waves from transmitters 1016 and 1013 of station N and M. Receiver 1017 at station P receives the modulated carrier directly from transmitter 1004 at station L. Receiver 1018 at station P receives a retransmitted signal from transmitter 1013 at station M, and receiver 1019 at station P receives a retransmitted signal from transmitter 1016 at station N. The outputs of receivers 1017, 1018, and 1019 at station P are all demodulated by detectors, and the various modulation frequencies in the outputs of each detector are separated by filters. At phase comparator 1020 the various modulation frequencies from the outputs of receivers 1018 and 1019 are compared as to phase. Similarly comparators, which are omitted from the illustration for the sake of simplicity, are used to compare the phases of the modulations in the outputs of receivers 1017 and 1019, and 1018 and 1017.

Claims 33, 37 and 60 to 64 stand rejected as being unpatentable over Nosker in view of Strobel. These references are adequately described on pages 3 and 4 of the Examiner's Statement, to which reference is made.

The Examiner applies the Nosker patent to the claims and purports to find in this reference all the elements recited in the instant claims except plural modulation frequency generators and plural receivers and phase comparators at the unknown station. Insofar as these elements are concerned the Examiner takes the position that "no invention is seen in utilizing a plurality of modulation frequencies as shown to be old by Strobel," or in placing a plurality of receivers and phase comparators at a station whose location is unknown in view of Figure 5 of Strobel.

Appellant challenges the Examiner's holding alleging that Nosker does not meet the terms of the instant claims because he uses a transmitter in an aircraft and makes his computations at a ground station where the source of modulation is located which allows the phase comparison means to pick up stray energy from the transmitter. Appellant points out that this reference compares the phase of a signal before transmission with the phase of this signal as received upon retransmission and does not compare the phases of the modulations of the various receiver carrier waves.

We have reviewed these claims in the light of appellant's remarks and are unimpressed by his contention that none of the transmitters of his system are carried on an aircraft since the claims contain no reference to an aircraft or what is contained therein. Likewise we are unimpressed by his contentions relative to some of the receiving stations of Nosker being located in such position as to pick up stray energy from the transmitter since this location of the receivers, shown in Figure 4 of the reference, is schematic and we consider it obvious to one skilled in the art that the signal generator and transmitter of this reference would be located at such a distance from the receivers that interference would be eliminated. However, we find that this reference does not compare the difference in phase in the modulations of received waves and, therefore, does not meet the terms of the claims. Accordingly, we will not sustain this ground of rejection.

Claims 33 and 37 are deemed to be unpatentable over Holmes in view of Strobel. Holmes points out that by radiating modulation waves from a plurality of known positions and receiving said waves at an unknown position the location of the unknown position may be determined by comparing the phase difference between the modulation frequencies carried by the various carrier waves in traveling from the known position to radio receivers at the unknown position.

Figure 2 of this reference discloses an arrangement for locating the position of a body. In this figure radio transmitters 15, 16 generate carrier waves of frequencies f_3, f_4, which are respectively transmitted from radiators or antenna 15*a*, 16*a* that are located at fixed positions of the order of 100 miles apart. A low frequency oscillation generated by source 19 connected to both transmitters and having a quarter wave length equal to the distance between the fixed positions, modulates the carriers f_3 and f_4 simultaneously and both modulations are radiated in phase at the transmitters. An aircraft traveling on a course between the two positions carries radio receivers 17, 18 and phase angle indicator 18*a*.

In the operation of the device the modulated carrier waves f_3 and f_4 radiated from fixed position 15*a*, 16*a*, are respectively received, amplified and demodulated by detectors which are part of radio receivers 17, 18 and applied to phase angle indicator 18*a*, which measures a difference in phase between the modulations taken from carrier waves f_3, f_4.

Holmes points out that if the modulations are emitted in phase or synchronism at the radiators or antennas 15*a*, 16*a* and the modulation frequency is such that one quarter of its wave length is equal to the distance between the radiators the phase angle between the modulations on the two carriers will be zero at a point equidistant from the radiators, at a point adjacent either one of the radiators the phase angles will be 90° which condition will be indicated by the indicator 18*a* and for other positions the phase angle in degrees will be proportional to the difference of the distance from each radiator to the position of the aircraft.

This inventor also explains that the modulations of the two carriers may be emitted in phase or synchronism by connecting the modulation source 19 to the two transmitters by wire lines and properly phased at one of the stations, as for example 15, by a phase shifter 19*a;* or alternately he proposes to locate the modulation source 19 at one of the transmitters, as for example 16, and modulate transmitter 15 in synchronism or phase by the modulation of the carrier wave radiated by transmitter 16 and received by a receiver located adjacent the transmitter 15 in the manner indicated in his Fig. 1.

In order to determine both the distance and azimuth angle of an aircraft from a given position Holmes proposes to use the apparatus shown in Figure 4. A station unit 35 is shown as comprising a modulation source 35*a* connected to modulate the carrier of a radio transmitter 35*b* which transmits a modulated carrier from radiator 35*c*. A second station unit 36 is shown spaced from the unit 35 and may comprise a radio receiver 36*a* adapted to receive the wave radiated from transmitter 35*b* and control the modulation of the carrier generated in transmitter 36*b* and radiated from the radiator 36*c*. Holmes also points out that when the stations 35 and 36 are radiating carriers which are modulated in synchronism or fixed phase relation, there is a definite phase relation between the modulation frequency as received along straight line A–A (Fig. 5) joining the two stations and the location of the point of reception on the line. Thus definite phase difference values represent different positions on this line. For any given value of phase difference existing on the line A–A, there are also other points in space in which the same phase difference exists. Lines may be drawn joining all the points of the same phase difference and the dotted line 31 in Figure 5 each represent such a line joining points of the same constant difference produced by stations 35 and 36. The lines, which form a definite pattern in space are called isophase difference lines and the phase difference as measured on one line differs by a given amount from the phase difference given on an adjacent line.

He states that any one of the lines may be used as a course and an airplane may follow any one of the lines by guiding the plane to maintain the phase indicator carried thereby at any predetermined value corresponding to a desired course. For any given course consisting of a particular value of phase difference, a deviation to a position left or right of the course produces a corresponding lead or lag of phase difference, as compared to the predetermined value, which may be used to provide automatic piloting of the plane when used in conjunction with well-known automatic control apparatus. A straight course may be flown by following the straight phase difference line 39*a* located symmetrically with respect to stations 35 and 36 or a curved course may be flown by following any of the other lines 39. The greatest curvature of these lines occurs adjacent line A–A, and at positions removed from the line these curves approach straight lines so that straight courses may be followed in the outer regions.

Holmes goes on to state that from this disclosure it may be assumed that when a pair of spaced radiators have their respective radiated carrier waves modulated with a common low frequency oscillation, the phase of which is maintained at fixed values at the respective radiators, a definite pattern of hyperbolic phase difference curves, extending transverse to a line through the radiators and corresponding to different values of phase difference between the modulating oscillation, may be located in space. This pattern of known curves fixed in relation to the spaced radiators, each of which curves can be particularly identified, may be used for navigational guidance, or for determining the distance of a body from an objective and they may also be used to provide a multiplicity of different courses each of known geographical location.

To provide for locating an aircraft in a wide area irrespective of whether the plane is flying a fixed course Holmes provides a second pair of spaced stations, as shown at 37 and 38 of Figure 5, and for the purpose of simplicity they may be located symmetrically with respect to stations 35 and 36 so that the units form the corners of a square. The stations 37 and 38 may be operated in accordance with the previously illustrated example of Figure 2 and stations 35 and 36 may be likewise operated and adjusted. The station 37 is spaced from both stations 35 and 36 and comprises a receiver 37*a* tuned to the modulation carrier wave radiated from 35*c* and is adapted to control a modulation of the carrier wave generated by transmitter 37*b* and radiated from 37*c*.

The spaced station 38 consists of a receiver 38*a* tuned to the modulated carrier wave from 37*c* and adapted to control the modulation of the carrier wave generated by transmitter 38*b* which is transmitted from radiator 38*c*.

With the units of each pair spaced the same distance from one another, the same modulation frequency may be used to modulate the carrier wave of each pair and a common modulation source such as source 35*a* may be employed for this purpose. With such an arrangement a carrier wave supplied by each of the stations may differ from one another so that they may be separately received.

Receiving equipment comprising two separate sets of receivers each set of which may be similar to that shown in Figure 2 will simultaneously receive waves from both pairs of stations and the phase angle indicators will provide two sets of perceptible indications so that the two coordinates required to plot the positions of the object are always available.

Holmes also points out that it is not necessary to use two separate pairs of stations and, by way of example, he considers that the stations 35, 36, 37 of Figures 4, 5 may be arranged in a triangular relation with a single source of modulation at the station 35, as shown in Figure 6. He states that with such an arrangement the phase difference of the modulation frequencies of one pair of stations such as 35, 37 may be compared with the phase difference of the modulations received from the other pair of stations, as for example stations 35, 36. The family of phase difference curves for the modulation frequency of stations 35, 37 is shown in dotted lines in Figure 6 while a family of phase different curves for modulation frequency of stations 35, 37 is indicated in solid lines in said figure. The curves may be used in the same manner as the curves shown in Figure 5.

We find from our analysis of the basic reference, Holmes, that it discloses a plurality of reference stations 35, 36, 37, a means 35*a* for generating a modulating frequency; means 35*b* for generating and impressing the modulating frequency on carrier energy; other of said reference stations comprising receivers 36*a*, 37*a* which include conventional detectors; means 36*b*, 37*b* for generating carrier waves different from any other carrier wave used in the apparatus and for modulating such carrier waves with the modulation frequencies received from reference station 35; an unknown station 41 which may utilize separate receivers which include conventional detectors for each of the carrier waves as shown in Figure 2; and phase angle indicators, as recited in these claims.

The basic reference does not simultaneously modulate the carrier wave at the reference station with a plurality of frequencies diminishing in amplitude, and equipment in each receiver at the unknown station for separating the modulating frequencies and comparing the phase of the modulations of the various received carrier waves.

The secondary reference Strobel teaches that radio distance measuring operations may be carried out by using a single modulation frequency but if greater accuracy or precision of measurement is required then several modulating frequencies diminishing in amplitude should be used. This reference also discloses (Figs. 5, 6) the apparatus for modulating a single carrier with plural frequencies as well as an arrangement of filters and phase indicators 62*a*, 62*b*, 62*c* for comparing the phase of corresponding modulating frequencies from pairs of receivers.

It is our opinion in view of the teaching of Strobel that it would be obvious to one skilled in the art where it was found necessary to increase the accuracy of Holmes' system to substitute for the single modulation transmitter of this reference a plural modulation transmitter, as shown in Figure 5 of the secondary reference, and to provide each receiver of Holmes with a plurality of filters and phase meters connected to corresponding filters in pairs of receivers, as shown in Figs. 5 and 6 of Strobel, since this modification of the basic reference produces no new or unobvious result but only its expected result and does not modify the mode of operation of the remainder of the apparatus of the basic reference.

This rejection is made under the provisions of Rule 196 (b).

Claims 33 and 37 are also deemed to be unpatentable over Shanklin in view of Strobel. The former reference discloses a hyperbolic position finding system in which transmitters operating on different carrier frequencies and located at positions A, B, C, and D may be modulated in synchronism or phase by either a single modulation frequency, which bears a definite relationship to the distance between two opposing transmitters or may be modulated by a plurality of frequencies as for example 150 cycles, 1500 cycles, 15000 cycles (page 1, column 2, lines 26–36) and radiated from the transmitters. A translational means, as for example an aircraft, operating in the area between A, B, C, D is equipped with a group of conventional receivers each of which is tuned to the carrier frequencies from one of the transmitters A, B, C, D and the output of which is connected to a parallel arrangement of filters tuned respectively to the modulation frequencies used at the transmitters, i. e. 150 cycles, 1500 cycles and 15000 cycles which in turn are connected through switches to a phase meter in such a manner as to measure the phase difference between the modulating signals in corresponding filters in the output of the receivers.

In analyzing claims 33, 37 it is found that the apparatus recited therein is so broadly defined that it reads on two transmitters used to determine the location of a translational means located on the line joining the two stations and on analyzing the basic reference we find it discloses a plurality of reference stations A, B (Fig. 1); a means for generating a plurality of modulation frequencies (page 1, column 2); a means for impressing modulation frequencies on a first carrier (page 1, column 2, lines 26–36) at one station; and on a second carrier at a second station (page 1, column 1, lines 23–30); receivers 10, 11, Figure 3, for the carriers having conventional detectors; equipment (filters 15–17) to separate the modulation frequencies and phase meters for comparing the phase of the modulations of the various receiving carriers as recited in these claims. We attach no patentable distinction to the simultaneous or successive measurements of the phase difference of the output of pairs of similar filters in the two receivers of Shanklin in view of the fact that Strobel suggests the method of successive (page 3, column 2, lines 49–68) or simultaneous (page 3, column 2, lines 69 et seq.) measurements of phase difference which we construe as a teaching of equivalence of the two methods and it is our opinion that adaption of Shanklin's device for the simultaneous comparison of the phase differences of each modulation would require only the skill of a mechanic.

We consider the term "synchronous" used by Shanklin as suggesting to one skilled in the art that the modulating signal may be generated at a central point and transmitted by a wire line or radio link, as shown for example in Figure 2 of Holmes or by generating the modulating signal at one of the transmitting stations, such as A, and transmitted by radio to a receiver at station B, as shown for example in Figure 5 of Holmes.

This rejection is made under the provisions of Rule 196 (b).

Claims 60 to 64 stand rejected as unpatentable over Holmes as a basic reference in view of Strobel as a secondary reference. The Examiner applies the reference Holmes to the claims and purports to find therein all the elements recited in these claims except a means for impressing on the carrier wave a plurality of modulations successively decreasing in frequencies and he takes the position that it is uninventive to use a plurality of modulating frequencies "in the same manner and for the same purpose as shown by Strobel." The Examiner alleges that "Strobel explains how distances up to one half the modulation wave length can be measured without ambiguity and that greater precision of the measurement can be obtained by using a higher frequency of modulation." The Examiner states "that Holmes considers his receiving equipment 41 to be old, and the patent to Shanklin is cited to show that such 'receiving equipment' is conventional and well known;" and alleges that "while Holmes may not show a plurality of receivers, it is well known that his 'receiving equipment' 41 will include a plurality of receivers as shown by Shanklin."

Appellant contends that the disclosure of the basic reference is confusing. He points out that Figure 6 of this reference uses three stations; transmits the modulation frequencies from station 35 to the plane and to stations 36 and 37, retransmits from 36 and 37 to the plane and compares the phase difference of the modulation frequencies from stations 35 and 37 with the phase difference from stations 35, 36 without saying why he makes such comparison or what such comparison would teach him. He argues that the secondary reference relates to a plain distance measuring system whereas his elected system (Fig. 10) does not determine distance directly but is based on the principle that by keeping the difference in phase constant an aircraft can be kept on a desired path of flight. Appellant points out that the secondary reference was issued 10 years ago and no one used this disclosure in a constant phase difference system and he considers the combination of the two references improper because the Examiner has failed to meet the requirement of *Ex parte* Gee that the Examiner must find in the prior art not merely a suggestion of the modification of the Holmes disclosure but also how to make the modification.

We have reviewed these claims in the light of appellant's arguments and find that the claims are broader in scope than claims 33 and 37 and are unpatentable over Holmes, as modified in the manner indicated in our rejection of claims 33 and 37.

We are unimpressed by appellant's contentions relative to the disclosure of Holmes being confusing. It is our view that the specification of this reference must be considered as a whole in interpreting its parts and when thus considered we find no confusion. For example, it would be obvious to one reading a description of Figure 6 of this reference to consider using the family of phase difference curves obtained from transmitters 35, 37 and transmitters 35, 36 in the same manner as indicated in the description of Figures 4 and 5. Holmes points out in connection with these figures that an aircraft having the necessary equipment may be caused to follow a given course or the pilot may use the reading of a pair of phase difference meters to locate his position on a geographical map. This descriptive matter is obviously applicable to Figure 6. Likewise we consider that Figure 2 of this reference would suggest to one skilled in the art that the schematic receiver such as shown in Figure 4 of the reference could consist of separate receivers and that page 5, column 2, lines 45 to 50 suggests the use of a single source of modulation for all transmitters at station 35 of Figure 4.

Likewise we are unimpressed by appellant's contention that Strobel discloses a distance measuring system whereas appellant's Figure 10 relates to a means for keeping an aircraft on a desired line of flight and for this reason it would not be obvious to use multiple modulation frequencies in the system of Holmes for any of the following reasons: (1) The systems of Figs. 4–6 of Holmes are developed from a distance measuring system similar to that disclosed by Strobel, compare for example Figures 1 of Holmes and Strobel. It would be obvious to one skilled in the art that the precision obtained by the use of plural modulation frequencies in the apparatus of Strobel would also be obtained in the device shown in Figure 1 of Holmes and that the advantages accruing from the use of plural modulations in Figure 1 of the latter reference would also be obtained in the device shown in Figures 4, 6 of this reference; (2) the rejected claims are not restricted to the device disclosed in Figure 10 of the instant application or to a device for keeping an aircraft on a desired path of flight, however, if the claims were so limited these features would not distinguish the instant claims from Holmes because they are found in this basis reference. The fact that the features are not found in the secondary reference is of no consequence since the Examiner in this rejection relied on the secondary reference for its teaching of improving the precision of radio distance measuring rather than its teaching of a system of measurement.

Appellant's contention relative to the age of the reference is without merit since the instant claims are not restricted to a constant phase difference navigation system but are broad enough to read on a position indicating system having plural modulations as shown by Shanklin. Furthermore it is well established that in attempting to ascertain the presence or absence of invention in the *claimed* device one should resort not only to the intelligence of a mechanic skilled in the art but also to the history and underlying state of the art at about the time of the alleged invention, the occasion for it, and the success it has attained. However, we cannot rely on that test when the record is silent as to any *factual* data. Although it is a factor to be considered, the fact that a patent is ten years old does not prevent it from being properly used as a reference and that in itself is as a rule insufficient to indicate the state of the art or the presence of invention. In re Worrest, 96 USPQ 381; 201 F. (2d) 930.

Likewise appellant's contention relative to an improper combination of the patents of Holmes and Strobel is without merit since it is well established that the Examiner may combine reference without finding a reference to teach the combination or how to make the modification where the claimed device is merely an assembly of old elements which produces only the sum of the functions of its separate parts and only the skill of a mechanic is necessary to assemble the parts in operative relationship.

The decision of the Examiner is affirmed as to claims 60–64 but is reversed as to claims 33 and 37. A new rejection of claims 33 and 37 is made under the provisions of Rule 196 (b).

BOARD OF APPEALS
L. P. MCCANN,
Examiner-in-Chief.
M. H. FRIEDMAN,
Examiner-in-Chief.
J. E. KEELY,
Examiner-in-Chief (*Acting*).

NOVEMBER 30, 1954.

DECISION OF BOARD OF APPEALS

ON

PETITION FOR RECONSIDERATION

PAPER NO. 33. EX PARTE DONALD H. JACOBS

Petitioner requests reconsideration of our decision of November 30, 1954 alleging (1) that this Board when using references of record cannot make a rejection under Rule 196 (b), (2) the Fig. 2 of Holmes is not compatible with his Fig. 4 and (3) that Strobel makes his phase comparisons by various manual switching and balancing operations performed in an appropriate sequence in contrast with petitioner's system which is completely automatic and requires no operator.

Petitioner's first allegation is without merit. It is well settled that this Board may change the order of the references the Examiner uses against any claim, or may drop one reference of a combination of references upon which the Examiner relies to reject a specific claim or claims (see *In re* Christensen et al., 35 CCPA 1000; 1948 C. D. 356; 611 OG 8; 166 F. (2d) 825; 77 USPQ 108; *In re* Cowles, 33 CCPA 1236; 1946 C. D. 574; 591 OG 509; 156 F. (2d) 551; 70 USPQ 419) without making a rejection under Rule 196 (b). However in other cases where a rejection of certain claims is made by the Board of Appeals that is not based on the same references and reasons as stated by the Examiner as to those claims, the Board clearly has the right to make such rejection under the provisions of Rule 196 (b). In such cases the Board's action avoids taking appellant by surprise and permits the claims involved to be further considered by the Examiner where appellant desires such consideration.

Likewise petitioner's second and third allegations are without merit. Page 6, column 1, lines 62 to 66 of Holmes provide for the use of the two receivers shown in Fig. 2 of this reference in the system of Fig. 6. Furthermore, we consider it obvious that a vehicle of fluid-borne craft in the area bounded by points 35–37, Fig. 6 of Holmes when receiving signals transmitted simultaneously at different frequencies from antennas located at said points need a pair of receivers such as 17, 18 Fig. 2 to pick up signals from antennas 35, 37 which are similar to 15a, 16a of Fig. 2 and an additional receiver which will cooperate with one of the aforesaid receivers to pick up signals from 35, 36 to operate in the manner recited on page 6, column 1, lines 40 to 51 of this reference.

Page 3, column 2, lines 69 et seq. of Strobel provide for the simultaneous transmission of three different modulating frequencies from a single transmitter and the simultaneous reception, comparison and indication of the phase difference between each of the component modulating frequencies and its generating source at the receiver. We direct attention to page 11, lines 11, 12 of our decision as to the manner in which Holmes is modified in view of Strobel.

Petitioner is not in a position to argue the superiority of his system or its components over their counterpart in the references for any of the following reasons:

(1) there is no evidence of record showing a comparison of the aforesaid systems or components from which we can draw a conclusion that appellant's system is superior.

(2) the filter member and phase comparator is shown in the instant drawing as a block diagram or as a section through a cathode ray tube and we are unable to determine from these diagrams or the cryptic description of these members in the instant specification how many manual switching and adjusting operations are necessary to make phase comparisons.

The petition has been granted to the extent of reconsidering our decision but is denied as to making any change therein.

BOARD OF APPEALS
L. P. MCCANN,
Examiner-in-Chief.
M. H. FRIEDMAN,
Examiner-in-Chief.
J. E. KELLY,
Examiner-in-Chief (*Acting*).

APRIL 25, 1955.

EXCERPTS FROM TRANSCRIPT OF RECORD DURING TRIAL HAD FEBRUARY 6 AND 7, 1957

(Page 2 of Transcript)

The COURT. Do you have a lawyer?
Mr. JACOBS. No, sir.

The Court. Well, don't you think you should have one?

Mr. Jacobs. Well, sir, this matter involves both technical and legal considerations. I think that it is a combination. From a technical point of view, a technical man is in a position perhaps to assist in the presentation of the case.

The Court. I will give you time to get a lawyer. I think you would be better off with a lawyer.

Mr. Jacobs. Well, thank you, but there are certain peculiar circumstances surrounding this particular case. * * *

(Page 9 of Transcript)

The Court. I still say that you ought to get a lawyer, and I am very serious about it.

I take it you are an engineer or a scientist?

Mr. Jacobs. Yes, sir. * * *

(Pages 24 and 25 of Transcript)

Mr. Jacobs. Well, sir, of course, it is our position that this is primarily an action for a patent and not primarily a review of an action.

The Court. Well, now, you are handicapped, not being a lawyer, but let me advise you that I am going to try to protect your rights. Of course, the Court is determining the matter de novo, but it is determining whether the Patent Office was in error or not. The Court does not start with a clean slate as though there had been no action in the Patent Office.

Mr. Jacobs. I appreciate that, sir. * * *

(Pages 41 and 42 of Transcript)

The Court. Well, now, are all your claims limited to the automatic feature?

Mr. Jacobs. I believe the bulk of them are. I wouldn't make a blanket statement under oath that all are without scrutinizing them once more.

The Court. Well, I think that is perhaps of some importance. I think it should be in the record.

Mr. Jacobs. I can give you a very rapid answer on that. Claim 33 has automatic phase comparators; 37 has; 60, I believe, just refers to phase comparators.

The Court. Well, "I believe" won't do.

Mr. Jacobs. Well, 60—well, let me point out this one principle, Your Honor. This is a principle that is set forth in the United States statute.

The Court. I beg your pardon?

Mr. Jacobs. This is a principle that is set forth in a United States statute, and it states that when you get a claim, refer to the piece of equipment, and that equipment is to be understood as referring to the description you give in the specifications.

The Court. Well, now, will you answer my question? Which claims are limited to the automatic features?

Mr. Jacobs. From my notes here, I would say, 33, 37, 62, 64. Those are the ones that specifically state automatic, according to my notes.

Mr. Roeming agrees with me on this.

The Court. Very well.

Mr. Jacobs. The others just refer to phase comparators, but according to the principle of the United States Code, I can give you the specific citation, the word phase comparators is sufficient to cover the phase comparators I have described in the specifications.

(Pages 42 and 43 of Transcript)

Mr. Jacobs. * * * The system has been constructed, and it has been put in operation, and it is considered by the United States Government to be a very important finding.

The Court. Where has it actually been in use?

Mr. Jacobs. The use of the system is in a classified piece of military equipment. We have turned equipment we have constructed over to the Government, and what they have done with it, A, we do not know and B, if we did, we probably could not say anything.

(Pages 45 and 46 of Transcript)

The Court. You may step down.

(Thereupon the witness [1] was excused.)

The Court. Well, I will hear you. I will hear defense counsel.

Mr. Roeming. Do you want me to make an argument?

The Court. I always expect some remarks from counsel, a very brief argument to be sure.

Mr. Roeming. Well, he has made no closing argument.

The Court. His testimony and his argument are all combined in one.

Mr. Roeming. Now, the chief reference relied on * * *.

---

[1] Mr. Jacobs, the appellant.

April 23, 1940. **P. J. HOLMES** **2,198,113**

NAVIGATION METHOD AND APPARATUS

Filed Sept. 30, 1938 4 Sheets-Sheet 1

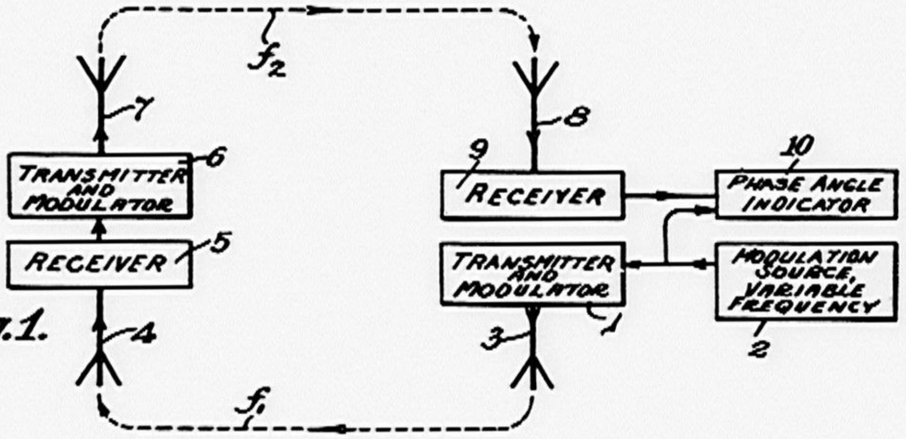
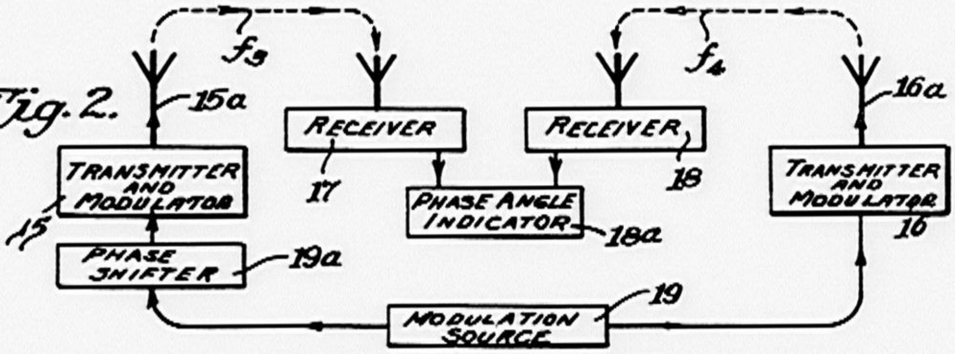

f_2
7
8
6
TRANSMITTER AND MODULATOR
9
10
RECEIVER
PHASE ANGLE INDICATOR
RECEIVER
5
TRANSMITTER AND MODULATOR
MODULATION SOURCE, VARIABLE FREQUENCY
1
4
3
2
f_1

Fig.1.

Fig. 2.



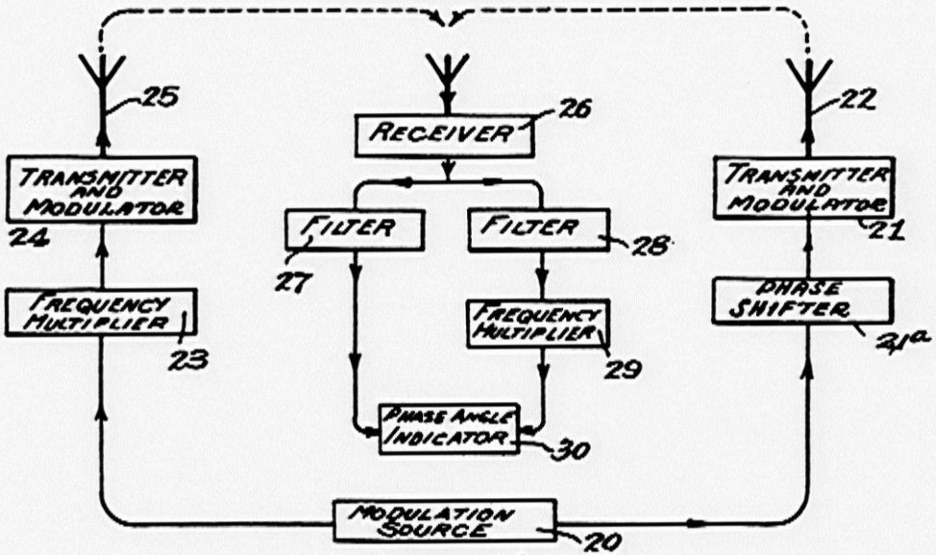


Fig.3.

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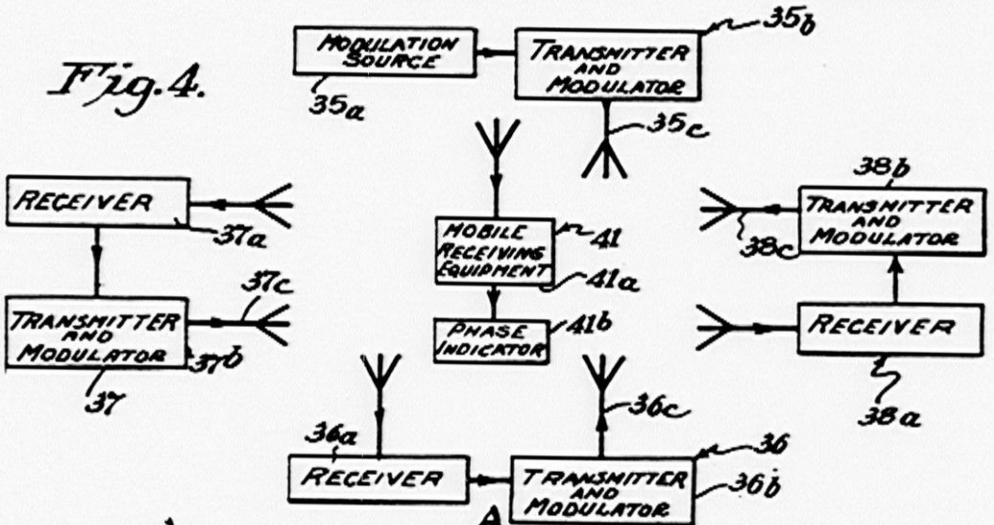
NAVIGATION METHOD AND APPARATUS

Filed Sept. 30, 1938 4 Sheets-Sheet 2

Fig. 4.


MODULATION SOURCE
35a
TRANSMITTER AND MODULATOR
35b
35c
RECEIVER
37a
TRANSMITTER AND MODULATOR
37c
37b
37
MOBILE RECEIVING EQUIPMENT
41
41a
PHASE INDICATOR
41b
38b
TRANSMITTER AND MODULATOR
38c
RECEIVER
38a
36a
RECEIVER
36c
36
TRANSMITTER AND MODULATOR
36b

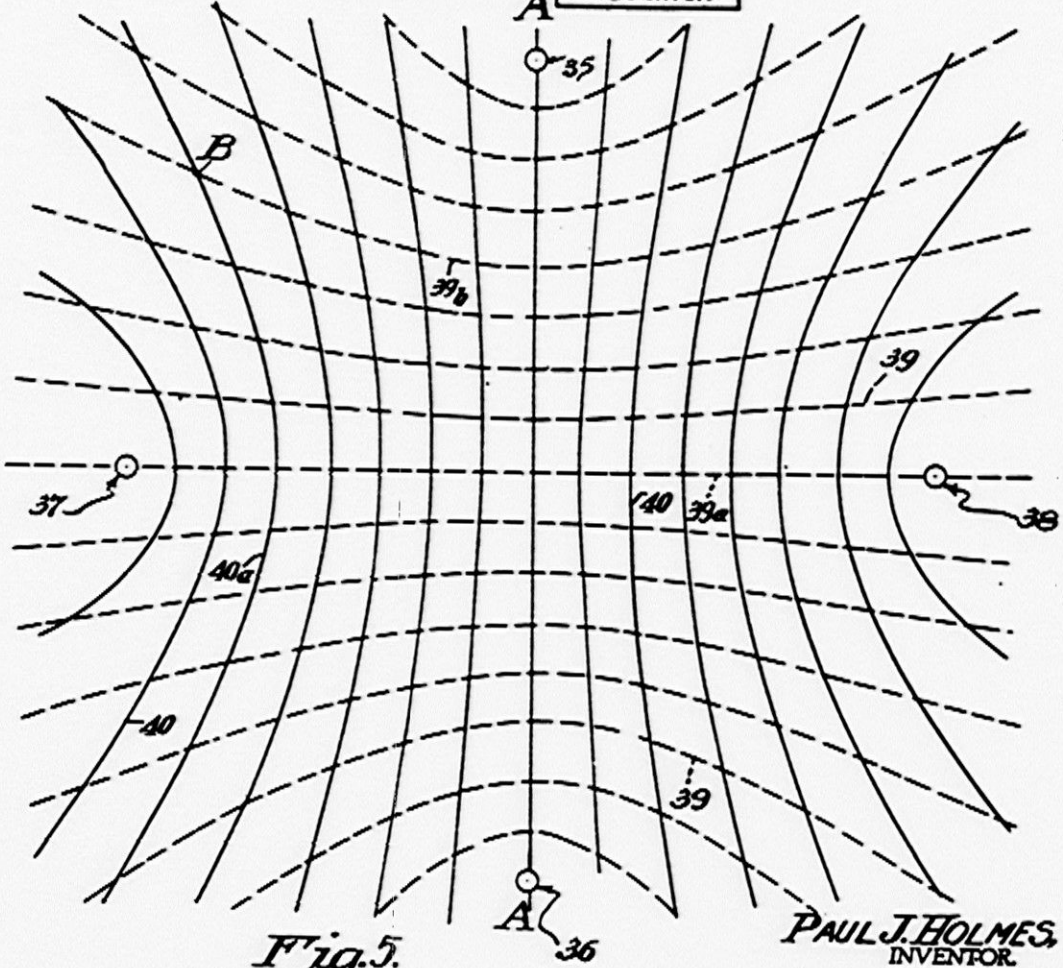


Fig. 5.

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NAVIGATION METHOD AND APPARATUS

Filed Sept. 30, 1938 4 Sheets-Sheet 3

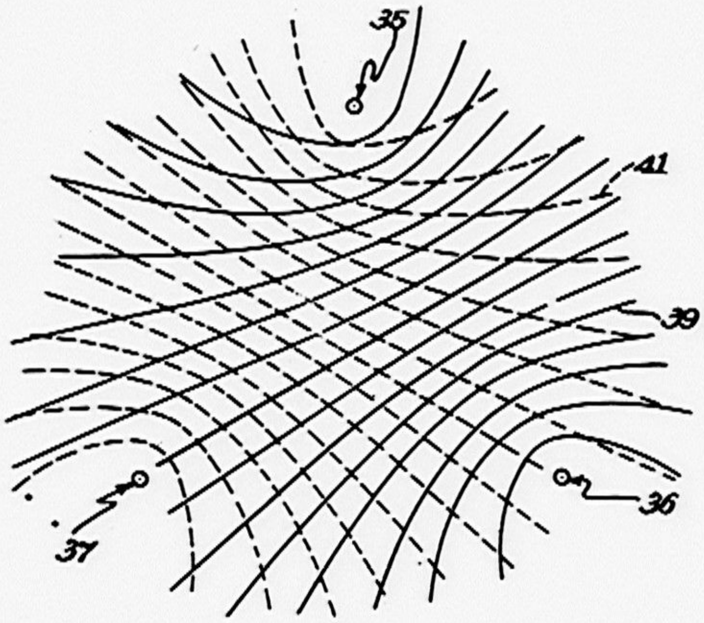

Fig. 6.

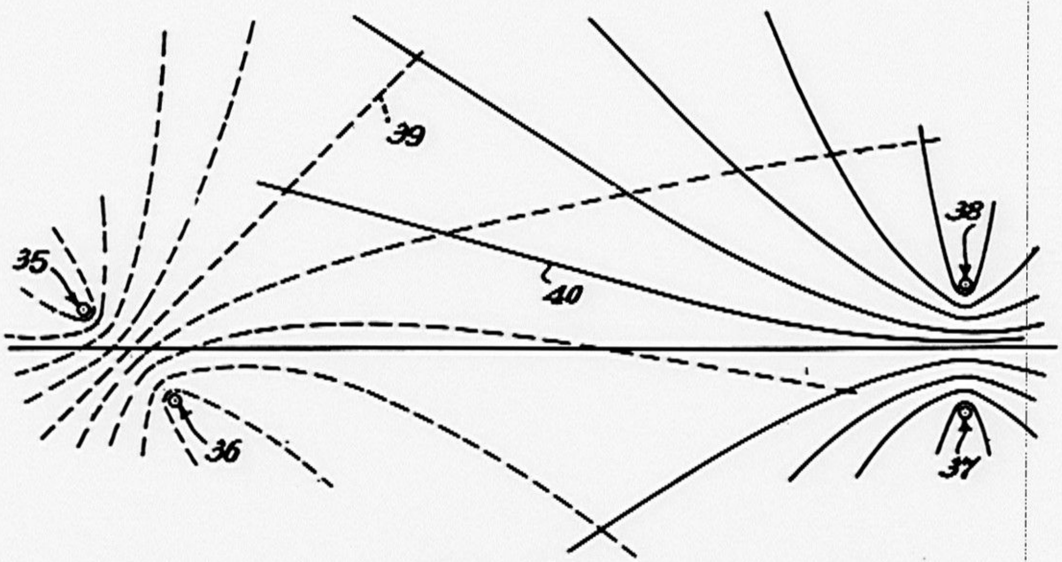

Fig. 7.

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NAVIGATION METHOD AND APPARATUS

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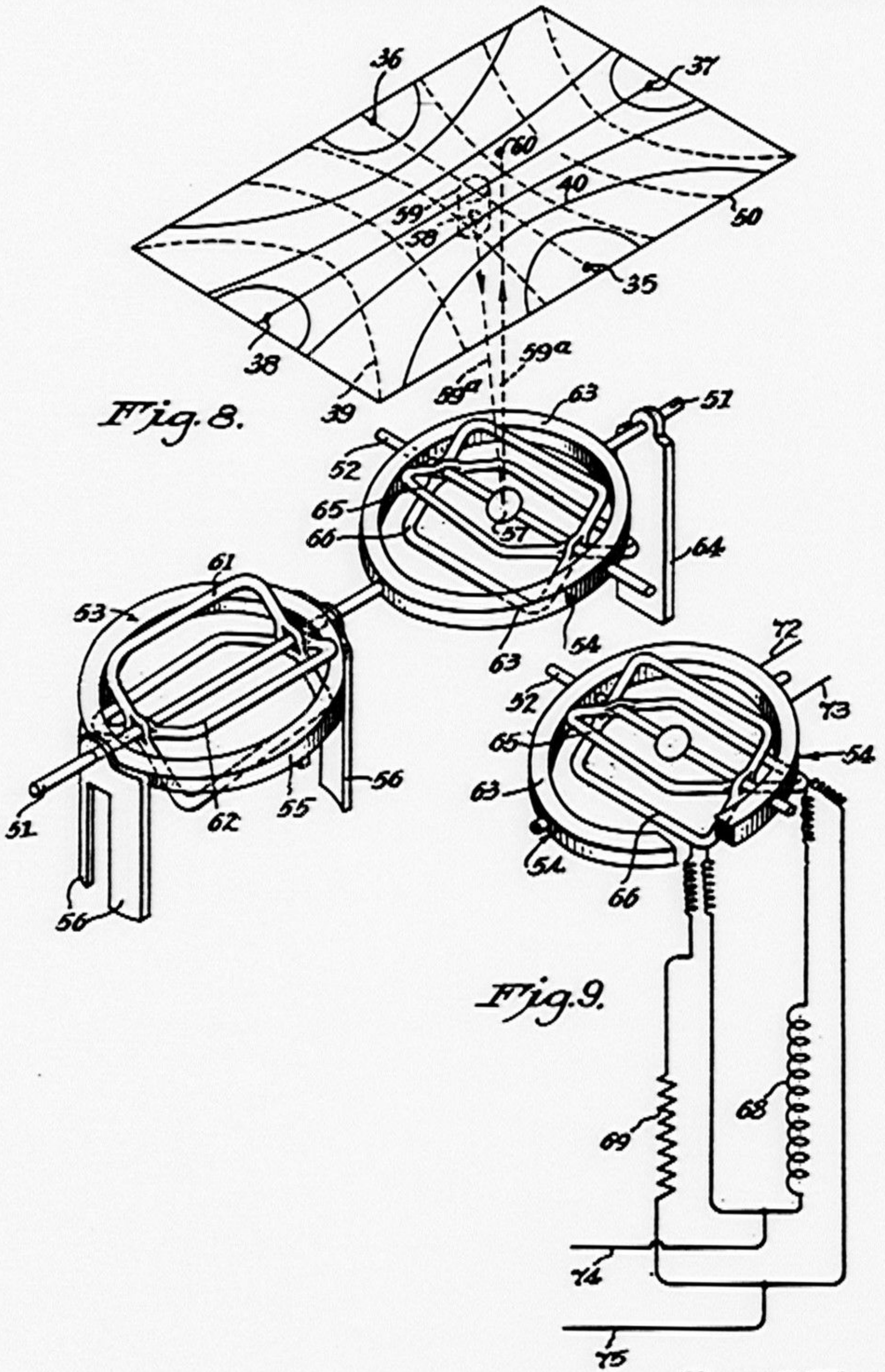

Fig. 8.

Fig. 9.

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Patented Apr. 23, 1940 **2,198,113**

UNITED STATES PATENT OFFICE

2,198,113

NAVIGATION METHOD AND APPARATUS

Paul J. Holmes, Los Angeles, Calif., assignor of forty per cent to William H. Donnelly, Los Angeles, Calif.

Application September 30, 1938, Serial No. 232,558

11 Claims. (Cl. 250—2)

This invention is concerned generally with aerial navigation and more particularly with a method and apparatus for determining the location of an airplane or other body. Determination of the location may be more or less comprehensive in the steps taken and the completeness of the data obtained; thus it may be sufficient to determine only the distance of the body from a known point or the presence of the body on a predetermined course, or it may be desired to further include a complete determination of position, as by horizontal azimuth and distance from a known point. It is to be understood that the method and apparatus herein disclosed and claimed are not limited to use with any particular body, as for example with airplanes, but are adapted for use in locating bodies in general, whether in the air or on land or water and whether moving or stationary. However, in order to clearly set forth an illustrative embodiment, my method and apparatus will be described primarily as employed for guiding and locating airplanes in flight, because it is particularly designed and adapted to this purpose.

Numerous radio navigation systems have been proposed and some of them are in use, and the principal shortcoming or limitation upon the usefulness of those systems used commercially is that they require directional transmitting and/or receiving apparatus. A system of triangulation is usually employed for determining the geographical location of a body. For example, a perceptible signal is radiated from the body and is received substantially simultaneously by two spaced direction-finders which obtain the directional bearing of the body. For any reasonable accuracy the body and the direction-finding stations are preferably arranged substantially in an equilateral triangle. It is not always possible to have the body and the direction-finding stations in an optimum triangular relation. There are definite disadvantages to this system because accurate directional bearings are frequently difficult to obtain. Furthermore, the bearings obtained have to be sent either separately or in correlated form to the airplane or mobile body. This requires time and involves human elements. Also, since numerous operations are involved, the errors produced by each operation are cumulative and tend to introduce a large error in the final data. Another disadvantage of such triangulation systems is that, with fixed direction-finding stations on the ground, the location service is available to only one body at a time instead of being continuously available to any or all of a number of mobile bodies located within a given area.

In some systems navigational guidance is provided by a radio beam consisting of a path or course of given angular direction and of known geographical location. Unless the airplane is on course to begin with considerable flight over unknown and hazardous terrain may be necessary before the plane arrives on the course of known geographical location.

With most navigation systems, as for example in the conventional radio beam system, it is difficult for the airplane to determine its distance along the beam from the beam source with any degree of accuracy. It is, therefore, a particular object of this invention to provide a method and apparatus which may be used in conjunction with existing systems to provide an indication of the distance of the body from a given location and when flying a given course to give the absolute geographical location of the body. For example, the methods and apparatus herein disclosed and claimed may be employed advantageously with the radio navigation method and apparatus disclosed and claimed in the copending application of William H. Donnelly and Paul J. Holmes, Serial No. 219,702, filed July 11, 1938.

A particular object of this invention is to provide a method and apparatus for determining the location of a body without the use of directional apparatus such as loop antennae.

A further object of the invention is to provide a method and apparatus with which the location of a body may be obtained without resorting to elaborate mathematics or to triangulation as is commonly employed and practiced.

A further object of the invention is to provide a method and apparatus for determining the distance between two radiating stations without employing a triangulation point.

Another object of the invention, according to one embodiment thereof, is to provide a method and apparatus with which the geographical location of a number of mobile bodies may be simultaneously determined.

A further object of the invention is to provide a method and apparatus for aerial navigation by means of which an airplane may fly a fixed course irrespective of the wind direction and velocity.

Another object of the invention is to provide a method and apparatus for determining the position of a mobile body on a map.

A further object of the invention is to provide a method and apparatus for recording, automatically and continuously, the movement and position of a mobile body on a map so that a record may be obtained which will be of value in case of a wreck or will furnish a basis for rating the ability of a pilot.

Another object of the invention is to provide a radio navigation method and apparatus which may be used in conjunction with well-known control equipment to provide for the automatic piloting of an airplane or other mobile body.

Another object of the invention is to provide a radio navigation method and apparatus which is relatively simple in operation and construction.

A further object of the invention is to provide a definite pattern in space formed by waves which are propagated from a plurality of spaced sources, and which pattern may be used for determining the location of a body.

Another important object of the invention is to provide a method and apparatus for determining the location of a body which is operative when the body is at any position within a relatively large area and is not confined to particular narrow zones of flight as when following the conventional radio beam.

Further objects and advantages of the invention, of which the above are typical, will become apparent as the description proceeds.

In general, radio, sonic and super-sonic waves are endowed with definite time and distance characteristics. Thus, a wave of a given frequency rotates a given number of electrical degrees in a given period of time and when the wave is radiated it travels a given distance in a given period of time. Thus, the phase rotation undergone by a radiated wave after radiation may be used as a measure of time and distance. The speed of travel of a radiated wave depends upon the medium through which the wave is propagated, which in turn determines the physical length of the wave. An electromagnetic wave travels through space at a constant speed approximating that of light or 186,000 miles per second.

For any given frequency the phase of the wave front, at a given distance from the point of radiation, has a definite and calculable relation to the phase of the wave front at the point of radiation. There is a phase rotation with distance which is a natural characteristic of propagated waves; and the distance between any two points in space located on a line radiating from the position of propagation, may be determined from the phase relation between the waves received at the two points. This requires basically the measurement of the time required for a propagated wave to travel between points in space whereby the distance between the points may be determined.

When a radio or electromagnetic wave is modulated by an oscillation, for example in the sonic wave spectrum, and propagated from a radiator, the carrier wave travels through space at the speed of light and the modulating oscillation impressed upon the carrier wave travels therewith at the same speed. Thus, it is apparent that the phase rotation undergone by an oscillation modulating a carrier wave after radiation may be used as a measure of time and distance.

Thus my invention includes essentially the steps of radiating a wave into space and determining the position of a body from the time required for the wave to travel between the body and a known position. In its broadest aspect my invention may be practiced with waves in general, that is, electromagnetic, sonic or supersonic waves. Since electromagnetic waves are useful over great distances and since the greatest utility of the invention resides in determining the location of the body over a considerable distance range, I will confine the description of the invention to the use of electromagnetic waves, and it will be understood that in general, satements concerning electromagnetic waves will also apply to other types of waves.

For example, the method of determining the location of a body according to my invention may include the steps of radiating a modulated electromagnetic wave into space from a known point which is spaced from the body. For example, I may radiate the modulated electromagnetic wave from a radiator located adjacent an airport and may receive the electromagnetic wave on a body such as an airplane at a position spaced from the airport. The modulation traveling on the radiated electromagnetic wave undergoes a phase rotation in traveling on the wave between the point of radiation thereof and the airplane, and I produce a perceptible indication which varies with changes in the magnitude of such phase rotation. Such a perceptible indication may be produced by directly comparing the phase difference between the modulation of the wave as received at the airplane and the modulation of the wave then being radiated. By radiating modulated electromagnetic waves from a plurality of known positions and receiving said waves on an airplane located at a position spaced from said known positions, the geographical location of the airplane with respect to the known positions may be determined by comparing the phase rotation undergone by the modulation frequencies carried by the various carrier waves in traveling from their positions of radiation through space to the radio receiver carried on the airplane.

Apparatus according to this invention for determining the position of a body includes essentially means for propagating waves into space and means for determining the time required for the waves to travel between a fixed position and the body. In one form, I may provide means for radiating modulated electromagnetic waves into space from a radio transmitter located at a fixed position spaced from an airplane and I may provide radio receiving means on the airplane for receiving said modulated wave and for producing a perceptible indication which varies with the phase of the modulation of the waves so received as compared to the phase of the modulation of the waves then being radiated.

The method and apparatus for making such location determinations include the following illustrative examples, which are better described in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagrammatic illustration of an apparatus for determining the distance between two radiators;

Fig. 2 is a diagrammatic illustration of an apparatus arrangement for obtaining the relation of a body with respect to two spaced radiators;

Fig. 3 is a diagrammatic representation of a variational arrangement of the apparatus illustrated in Fig. 2;

Fig. 4 is a diagrammatic illustration of an apparatus arrangement which may be used to determine the position in space of a body;

Fig. 5 illustrates phase conditions which may be obtained in space when using the apparatus arrangement illustrated in Fig. 4;

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Figs. 6 and 7 are diagrammatic representations of modified arrangements of the apparatus illustrated in Fig. 4;

Fig. 8 is a diagrammatic representation of an apparatus for indicating or recording the position of a body; and

Fig. 9 is a diagrammatic representation of a phase angle responsive means.

Referring to Fig. 1, a radio transmitter 1 with modulation source 2, and a radio receiver 9 with phase angle indicator 10, are located on a mobile body, such as an airplane in flight. Radio receiver 5 and transmitter 6, as shown, are located at a fixed position such as the destination or landing field of the airplane. A low frequency oscillation, generated by modulation source 2, modulates the carrier wave of frequency f_1, generated by radio transmitter 1, which is radiated from radiator 3. The modulated carrier f_1 is intercepted by antenna 4, amplified and demodulated by receiver 5, and applied to control the modulation of carrier wave of frequency f_2, generated by radio transmitter 6, which is radiated from radiator 7. Antenna 8, located on the mobile body, intercepts the modulated carrier f_2, which is amplified and demodulated by receiver 9 and the modulation fed to the phase angle indicator 10. The phase angle indicator 10 is also connected to the modulation source 2. The phase angle indicator may comprise a direct reading indicator, such as a modified crossed coil Tuma indicator or it may comprise a cathode ray tube with one set of deflection plates connected to the output of the receiver and the other set of plates connected to the modulation source 2. In any event the literature is replete with indicating phase angle meters and the most advantageous meter is a matter of selection. The receiver 5 and transmitter 6 may be so constructed and adjusted that the radiated modulating oscillation of f_1 intercepted by antenna 4 is radiated by radiator 7 on f_2 in phase, so that in effect, the modulating oscillation radiated from 3 is reflected from the fixed position of 4 and 7 back to the position of 8 and 3.

The radiated low frequency oscillation of modulation source 2, modulating the carrier waves of f_1 and f_2, travels through space from the mobile body to the fixed position, where it is, in effect, reflected back to the mobile body all at the speed of light. It therefore has definite values of phase rotation for definite distances between the mobile body and the fixed position. The phase angle as indicated in indicator 10 will have a value that is in direct proportion to the distance between the mobile body and the fixed position. As an example, when the frequency of the modulation source 2 is 5,000 cycles per second, the wave length is 37.2 miles. If the phase angle indication at 10 is 180° the distance existing between the mobile body and the fixed position will be 9.3 miles, that is, a quarter wavelength of the oscillation will exist between the mobile body and the fixed position, and since the radio station at the fixed position, in effect, reflects the oscillation, a quarter wavelength will likewise exist between the fixed position and the mobile body. When the frequency of the oscillation is 500 cycles per second, and the phase angle indication 90°, the distance of the mobile body from the fixed position will be 46.5 miles. Thus, for a given frequency, the distance of the airplane from the fixed position may be readily determined from the value of the phase angle indicated in indicator 10. Alternatively, I may vary the frequency of the modulation source 2 to give a predetermined phase angle reading at 10, for example 90°, and determine the distance of the airplane from the fixed position by the value of the frequency required to bring about the predetermined value of phase angle indication.

It is appreciated that the transmitters and receivers may produce a phase displacement of the modulating oscillation in addition to the phase displacement occurring in space. However, suitable phase changing networks as are well known to the art, may be introduced into the system to compensate for the phase displacement produced by the receiving and transmitting equipment. In any event, any appreciable change in displacement produced by the equipment can be taken into consideration.

In effect, according to this invention, the position of the body, with respect to a known location, is determined by measuring the length of the superimposed wave existing in space between the body and the known position, or alternatively, the location of a body is determined by obtaining a perceptible indication which depends upon the length of time required for a wave to travel through space between the body and the known location. Theoretically, it is not necessary to reflect the modulating oscillation back to its source to determine its phase rotation through space as there will be an apparent change 'n the phase of the modulation as received in a distant location as compared to the phase of the modulation, at a given time, at the position of radiation thereof. However, at the present time there are not any time standards that may be maintained with the desired degree of accuracy, so the reflected wave is used to provide a convenient time standard.

Referring to Fig. 2, a somewhat modified arrangement for determining the location of a body is illustrated, which has an advantage over Fig. 1 in that it is not necessary to transmit and receive simultaneously on the body. Radio transmitters 15 and 16 generate carrier waves of frequencies f_3 and f_4, which are respectively radiated from radiators 15a and 16a. The radiators and transmitters are located at two spaced fixed positions, for example on the order of 100 miles apart, which positions, we may assume for the moment, are two airports located on a course to be traveled by an airplane. A low frequency oscillation, generated by modulation source 19 connected to both transmitters, modulates the carrier waves f_3 and f_4 simultaneously. Radio receivers 17, 18 and phase angle indicator 19a are mounted on the mobile body, such as the airplane traveling on the course between the two airports. The modulated carrier waves f_3 and f_4, simultaneously radiated from the fixed positions 15a and 16a, are respectively received, amplified and preferably demodulated by receivers 17 and 18. The resulting modulation from each of the receivers is fed to the phase angle indicator 19a, which may be a direct reading indicator or meter of any one of the various types.

The frequency of the modulating oscillation may have any given wavelength relation to the distance between the radiators 15a and 16a. I prefer to utilize a frequency of oscillation such that one-quarter of its wavelength is equal to the distance between the radiators, considering the velocity of propagation equal to the speed of light. For convenience, I also prefer that the modulating oscillation is radiated in phase at

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the radiators. Assuming that the modulation source 19 is connected to the transmitters by land lines, this phasing may be readily accomplished through the use of suitable phasing networks, as is apparent to those skilled in the art. Such a network is indicated by phase shifter 19a connected between modulation source 19 and transmitter 15.

It is apparent that if the carriers radiated by the two radiators 15a and 16a are modulated by the same modulation frequency and in a definite phase relation, for any given position in space the phase relation between the modulating oscillations on the two carriers f_3 and f_4 will have a definite and fixed relation.

To take a simple case, when the modulating oscillation is radiated in phase at the radiators 15a—16a and the modulation frequency is such that one-quarter of its wavelength is equal to the distance between the radiators, the phase angle between the modulations on the two carriers will be zero at a point equidistant from the radiators. At a position adjacent either one of the radiators the phase angle will be 90°, which condition may be indicated in the indicator 18a, and for other positions the phase angle in degrees will be proportional to the difference of the distances from each radiator to the position of the body. In other words, the phase angle changes in proportion to the distance traveled between the radiators.

Thus, the phase angle indicator carried on the mobile body may be calibrated directly in terms of distance from the radiators 15a or 16a and may consist of a zero center type meter with 90° lag occurring at the left of zero and 90° lead at the right of zero. For the above case, by utilizing the modulation of one carrier wave received on the mobile body as a reference wave, the phase angle indicated by 18a will lead when the mobile body is adjacent one of the radiators and will lag when adjacent the other radiator. A maximum or minimum of 90° will occur when the mobile body is directly adjacent one of the radiators. It is now apparent that the geographical location of an airplane traveling on a direct course between two airports may be indicated by the phase angle reading described above, and that the phase angle indicated will change in direct proportion with the distance of the airplane out along the course.

It will be appreciated that the transmitters 15 and 16 need not be connected by land lines to the modulation source 19 and that the time synchronization of the modulation frequencies supplied to the transmitters may be accomplished in other manners. For example, the modulation source 19 may be located adjacent the transmitter 16 and connected thereto by a wire line. The transmitter 15 may be modulated by the modulation of the carrier wave transmitted by transmitter 16 and received in a receiver located adjacent the transmitter 15 after the manner of the receiver and transmitter 5 and 6 in Fig. 1.

It can be seen that when two stations have a fixed space between them they may be synchronized to modulate in any desired phase relation by simply adjusting the frequency of the modulating oscillation until the desired phase relation is obtained. In effect a standing wave pattern of the low frequency modulating oscillation is produced in the space between the radiators, which has definite phase relations at definite positions between the radiators. This standing wave pattern may consist of any portion of a cycle or any number of cycles of the low frequency modulating oscillation, the exact value being dependent upon the frequency.

A variational form of my apparatus is illustrated in Fig. 3, in which spaced radiators 22, 25 and radio transmitters 21, 24 are shown. A modulation source 20 supplying a modulation frequency of say 500 cycles per second, is directly connected to transmitter 21 where the 500 cycle modulation frequency is impressed upon the generated carrier wave and radiated at a given carrier frequency into space from radiator 22. The modulation source 20 is also connected by suitable means, as through land lines, to a frequency multiplier 23 which, for the purposes of illustration, may double the supplied modulation frequency, thus supplying a 1,000 cycle modulation to transmitter 24, where this modulation frequency is impressed upon the generated carrier wave radiated from radiator 25 at a given carrier frequency.

The frequencies of the carrier waves generated by the transmitters 21 and 24 may be the same and the distance between the respective radiators 22 and 25 is preferably such that the 1,000 cycle modulation rotates 90° in phase in traveling through space between the radiators. The phase of the modulation frequencies superimposed upon the radiated carriers should bear a known or constant relation to one another as they are radiated from their respective radiators 22 and 25. This may be accomplished by the use of well known means such as a phase shifter 21a. A receiver 26 carried on a mobile body located at some position between the radiators 22 and 25 and for the purposes of example on the line joining the radiators, may be tuned to simultaneously receive the modulated carrier waves radiated by the radiators 22 and 25. The received waves may be demodulated and fed to filters 27 and 28 where the modulations are separated. Filter 27 is adapted to pass the 1,000 cycle modulation and reject the 500 cycle modulation, while filter 28 is adapted to pass the 500 cycle modulation and reject the 1,000 cycle modulation. The output of filter 27 is connected to the phase angle indicator 30. The output of filter 28 is fed to a frequency multiplier 29 which multiplies the applied frequency by an amount corresponding to the frequency multiplier 23 . Thus the two different separate modulation frequencies are changed to two separate modulations of the same frequency. The output of the frequency multiplier 29 is also connected to the phase angle indicator 30, where in effect the phase of the modulation of the carrier wave received from radiator 25 may be compared to the phase of the modulation of the carrier wave received from radiator 22 by comparing the phase relation of the two separate modulations of the same frequency. When the receiver 26 is located on the line joining the radiators 22 and 24, the position of the mobile body carrying the receiver may be directly ascertained by the phase difference reading as described in relation to Fig. 2

Referring to Figs. 4 and 5, an apparatus arrangement is illustrated which may be used to directly determine the location of a body such as an airplane, that is, the distance and azimuth of an airplane from a given position. A station unit 35 is shown as comprising a modulation source 35a connected to modulate the carrier of a radio transmitter 35b which radiates a modulated carrier from radiator 35c. A second station unit 36 is shown spaced from the unit 35

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and may comprise a radio receiver 36a adapted to receive the wave radiated from transmitter 35b and control the modulation of the carrier generated in transmitter 36b and radiated from the radiator 36c. As was brought out above, when the stations 35 and 36 are radiating carriers which are modulated in a fixed phase relation, in any of the manners described in relation to Figs. 1–3, there is a definite phase relation between the modulation frequencies as received along straight line A—A joining the two stations and the location of the point of reception on the line. Thus definite phase difference values represent definite positions on this line. For any given value of phase difference existing on the line A—A, there are also other points in space in which the same phase difference exists. Lines may be drawn joining all the points of the same phase difference and the dotted lines 39 in Fig. 5 each represent such a line joining points of the same constant phase difference produced by stations 35 and 36. The lines, which form a definite pattern in space, may be called isophase difference lines and the phase difference as measured on one line differs by a given amount from the phase difference as measured on an adjacent line.

Any one of the lines may be used as a course and an airplane may follow any one of them by guiding the plane to maintain the phase indicator carried thereby at any predetermined value corresponding to a desired course. For any given course consisting of a particular value of phase difference, a deviation to a position left or right of the course produces a corresponding lead or lag of phase difference, as compared to the predetermined value, which may be used to provide automatic piloting of the plane when used in conjunction with well-known automatic control apparatus. A straight course may be flown by following the straight phase difference line 39a located symmetrically with respect to stations 35 and 36 or a curved course may be flown by following any of the other lines 39. The greatest curvature in these lines occurs adjacent line A—A, and at positions removed from the line these curves approach straight lines so that straight courses may be followed in the outer regions.

For this disclosure, it may be assumed that when a pair of spaced radiators have their respective radiated carrier waves modulated with a common low frequency oscillation, the phase of which is maintained at fixed values at the respective radiators, a definite pattern of hyperbolic phase difference curves, extending transverse to a line through the radiators and corresponding to different values of phase difference between the modulating oscillation, may be located in space. This pattern of known curves fixed in relation to the spaced radiators, each of which curves can be particularly identified, may be used for navigational guidance, or for determining the distance of a body from an objective and they may also be used to provide a multiplicity of different courses each of known geographical location.

If an airplane is flying a known course such as line A—A which is intersected by lines 39, as for example on a radio beam extending along line A—A, the exact location of the plane may be determined from the value of the phase difference obtained at any point on the course. To do this the pilot may be provided with a map upon which the course is shown along with the isophase difference lines provided by one or more pairs of stations in the area. It is readily apparent that the present airway radio range stations may be utilized as the spaced radio stations in this invention and more especially the simultaneous radio range and telephone transmission stations being installed for simultaneous range and weather broadcasts by the Bureau of Air Commerce. As an example for the last-mentioned system, the carrier wave radiated from the central non-directional radiator being used for weather broadcasts may be modulated with the desired modulation frequency producing the previously described isophase-difference lines. Thus location of an airplane on a radio range course may be determined by providing an additional receiver and suitable filter networks of the band pass and band rejection type connected to a phase angle indicator. Also, a predetermined value of phase difference may be utilized as a marker to indicate the intersection of the beams from the spaced radio range stations used.

Referring again to Figs. 4 and 5, to provide for locating an airplane in a wide area irrespective of whether the plane is flying a fixed course, I may provide a second pair of spaced stations as shown at 37 and 38 of Fig. 5, and for the purposes of simplicity they may be located symmetrically with respect to stations 35 and 36 so that the units form the corners of a square. The stations 37 and 38 may be operated in accordance with the previously illustrated examples of either Figs. 1, 2, or 3 and stations 35 and 36 may be likewise operated and adjusted. The station 37 is spaced from both stations 35 and 36 and comprises a receiver 37a tuned to the modulated carrier wave radiated from 35c and is adapted to control the modulation of the carrier wave generated by transmitter 37b and radiated from 37c. The spaced station 38 consists of a receiver 38a tuned to the modulated carrier wave from 37c and adapted to control the modulation of the carrier wave generated by transmitter 38b which is radiated from radiator 38c.

With the units of each pair spaced the same distance from one another, the same modulation frequency may be used to modulate the carrier waves of each pair and a common modulation source such as source 35a may be employed for this purpose. With such an arrangement the carrier waves supplied by each of the stations may differ from one another so that they may be separately received. Obviously the carrier waves radiated from one pair may be the same and a different carrier wave frequency may be used for the other pair. In this event the modulation frequency supplied to one station of a pair will be different from the modulation frequency supplied to the other station of the pair. Since optimum results are obtained when the stations of any one pair are spaced by a distance which is equal to or less than the distance traveled by the carrier wave while the modulation undergoes a phase rotation of 90°, it may be seen that it will be advantageous in some instances to space each pair of stations at different distances so that different modulation frequencies may be employed and so that each pair of stations may be readily identified.

Receiving equipment 41 which may be carried on an airplane is shown as comprising a radio receiver 41a which is capable of receiving the modulated carrier waves from either pair of stations 35 and 36 or 37 and 38 and which further includes a phase angle indicator 41b that

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will produce a perceptible indication which will vary in accordance with the phase difference between the modulation of the carriers so received.

Referring now to Fig. 5, the stations 35 and 36 are adjusted to provide the phase difference lines indicated by the dotted lines 39 and the stations 37 and 38 are adjusted to provide the phase difference lines indicated by the solid lines 40. Assume that the mobile receiving equipment 41 is tuned to receive from stations 35 and 36 and that the phase difference as indicated by the phase angle indicator 41*b* corresponds to a value represented by dotted line 39*b*, the airplane is then known to be located at some position on this line. If the receiving equipment of 41 is now tuned to receive from stations 37 and 38 and the phase angle indicator 41*b* shows the phase to be of a value represented by the solid line 40*a*, the absolute location of the airplane carrying the mobile receiving equipment is indicated by the intersection of the two lines at B. To facilitate determining the location of the airplane, the stations and the isophase difference lines 39 and 40 may be drawn on a geographical map so that the pilot of the airplane may plot his position on this map. Obviously the mobile receiving equipment may include means to receive the waves substantially simultaneously from both pairs of stations and the phase angle indicator 41*b* may include means for simultaneously producing two sets of perceptible indications, so that the two coordinates required to plot the position are always available.

It is also within the contemplation of this invention, to provide means for combining these two coördinates to automatically and continuously indicate the location of the airplane on a map or other means carried thereby, as will be described hereinafter.

From consideration of the above figures it may be seen that it is not necessary to utilize two separate pairs of stations. For example, the stations 35, 36, and 37 of Figs. 4 and 5 may be arranged in a triangular relation as indicated and shown in Fig. 6. With such arrangement the phase difference of the modulation frequency of any one pair of stations, for example, the stations 35 and 37, may be compared with the phase difference of the modulations received from the other pair of stations, for example, the stations 35 and 36. A family of phase difference curves, in Fig. 6, for the modulation frequency of stations 35 and 37 is indicated by dotted lines 41 and the family of curves for the phase difference of the modulation frequency of stations 35 and 36 is indicated by the full lines 39. It is assumed that the modulation frequency of stations 36 and 37 is supplied from the modulation source 35*a* as shown in Fig. 4 and that this modulation frequency is the same for all the stations. With this arrangement the carrier wave frequencies of stations 35, 36, and 37 are preferably different. Obviously any of the receiving and transmitting arrangements described in relation to Figs. 1 to 5 may be used with the arrangement shown in Fig. 6.

It is interesting to note that the present airway radio range stations of the RA type with the central non-directional radiator may be used for the spaced radio stations as hereinbefore related. Thus it may now be seen that the radio range stations in addition to providing narrow courses or beams for airplanes may be employed to give the position out along the beam. Wherever the radio range stations form triangles the geographical location in the A or N areas may be obtained on the airplanes with the above modification as shown in Fig. 6, and since the radio range stations cover the United States, transcontinental passenger airplanes may therefore determine their geographical location whether on the radio beam or not. Normally in good weather the planes depend upon compass direction and landmarks for navigation. Thus when they are off the radio beam and fly suddenly into overcast regions the location of the plane from the beam may be quickly determined.

The method and apparatus of this invention is not necessarily limited to providing guidance or to determining the location of an airplane over a course which is comparable in length to the distance or separation between any pair of stations, but may be advantageously employed in navigating a plane over courses which are considerably longer than the separation between the stations. Referring to Fig. 7, stations 35 and 36 are shown separated by a relatively short distance, for example on the order of ten miles, more or less, to provide guidance along a course which may extend for a distance of 100 to several hundred miles. For example, an airplane may fly a straight or curved course along any one of the lines of constant phase relation 39 by maintaining the phase difference between the modulation frequencies received from stations 35 and 36 at a predetermined value, for example, 45°. The position of an airplane in flight along one of these paths of constant phase displacement as supplied by stations 35 and 36 may be readily determined by setting up a second pair of stations 37 and 38, so that the lines of constant phase relation produced thereby intersect the course to be followed by the plane. The pairs of stations are angularly displaced in such a manner that when the plane is flying on the given course the phase angle reading supplied by the stations 37 and 38 as indicated by phase difference lines 40, uniquely determines the position of the plane at that instant. It is not necessary for the plane to be exactly on the course to determine its location, since the phase angle reading taken on the stations 35 and 36 and then taken on stations 37 and 38 will immediately determine the location of the plane.

Obviously any straight, angular or curved courses may be flown over great distances by providing a sufficient number of properly spaced and modulated stations in accordance with the preceding description as should now be apparent.

Referring to Fig. 8, an arrangement is shown with which the course followed by a body, as well as the position of the body at any time, may be directly indicated or recorded. The apparatus as shown is primarily adapted for use with the apparatus illustrated in Fig. 4, although it may be used after obvious modification with the three-station arrangement illustrated in Fig. 6. The apparatus may comprise a translucent screen 56, upon which may be mounted a translucent map of the area over which the body is traveling with station units 35, 36, 37, and 38 marked upon it, which is shown positioned above light-directing means 57 mounted for angular rotation about two mutually transverse axes represented by shafts 51 and 52 respectively. A light source 58 is shown mounted in a housing and lens tube 59 so as to provide a light beam 59*a* which is directed by the light-directing means (a reflector in this case) to the translucent screen and map to provide a light spot 60 which may be caused to

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traverse the translucent screen 58 upon movement of either one or both of the shafts 51 and 52.

Actuating means for producing angular movement of shafts 51 and 52 are indicated respectively at 53 and 54 and are shown as comprising phase angle responsive means comparable to a common form of crossed coil Tuma phase angle indicator. The actuating means 53 is shown as comprising a field coil 55 mounted in a fixed position by supports 56 which may also provide bearings for shaft 51. Crossed coils 61 and 62 are fixed to the shaft 51 and are adapted to rotate the shaft 51 in accordance with changes in phase angle, as will be described more completely hereafter. The shaft 51 comprises one of the transverse axes about which the light-directing means 57 is moved and is secured to field coil 63 of second actuating means 54 and is adapted to rotate the actuating means 54 as a unit. A support is shown at 64 to provide another bearing for the shaft 51. The actuating means 54 is also provided with crossed coils which are designated as 65 and 66 and which are adapted to produce rotation of the shaft 52 in accordance with changes in phase angle. The shaft 52 constitutes the other of the transverse axes, and the light-directing means 57 is affixed thereto. The drawings being highly diagrammatic, no bearings for the shaft 52 are shown. Suitable means, not shown, are provided for connecting the actuating means 53 to the mobile receiver 41 for example, so that the rotation of shaft 51 will be in response to the phase difference between the modulations received from stations 35 and 36 while the actuating means 54 may be connected to the mobile receiver 41 in such manner as to be responsive to the phase angle between the modulations received from the stations 37 and 38.

In Fig. 9 the connection diagram for one of the actuating means, 54 for example, is shown in more detail. Field coil 63 is provided with leads 72 and 73 for connection to the mobile receiver 41*a* to carry the modulation obtained from said receiver from station 37, for example. Crossed coils 65 and 66 are shown positioned within the field coil and are carried by actuating shaft 52.

As is customary with such indicators, one of the crossed coils, 65 for example, is connected through an inductance 68 to a connecting lead 74 and the other of said coils is connected through a resistor 69 to another connection 75. Thus the currents in the coils 65 and 66 may be made to have any desired phase difference, for example 90°. By connecting leads 74 and 75 to the mobile receiving equipment 41*a* so as to carry the modulation supplied by station 38, the shaft 52 may be made to occupy different angular positions dependent upon the phase difference between the modulations obtained from receiver 41*a* and received from stations 37 and 38. It will be appreciated that the shaft 52 may carry a pointer and be used as a direct indicating phase angle responsive means, in which case the actuating means may be used as a phase angle meter in any of the previously described embodiments of my invention.

It may be seen that by rotation of either shaft 51 or 52 separately, one of the hyperbolic lines 39 or 40 will be traced on the translucent screen. The apparatus may be arranged so that these hyperbolic lines will have the same pattern or shape as those actually located in space with respect to the stations 35, 36, 37, and 38. With rotation of the light beam source around both axes 51 and 52, the spot of light produced upon the translucent screen by the light beam will automatically indicate the intersection of any two of the lines 39 and 40.

With the arrangement shown in Fig. 8 the housing and lens tube 59 will cast a shadow on the screen 58 when the light beam 59*a* is reflected directly back at the light source, corresponding to a position of the body in the center of the screen. However, this should present no particular disadvantage, since the lens tube may be made comparatively small. If desired the lens tube and light source may be located to one side of the screen, in which case the rest position of the reflecting means will be changed to take care of this situation. Also, the light-directing means 57 may comprise the lens tube 59 if desired.

Also, when it is difficult to obtain sufficient power to operate directly from the actuating means 53 and 54, other means such as control motors may be substituted for the actuating means to produce rotation of the shafts 51 and 52. Motors comparable to the potentiometer controlled "Modutrol" motors of the Minneapolis Honeywell Regulator Company may be used, in which case the actuating means 53 and 54 may be used to operate the control potentiometers of such motors.

By use of the gimbal arrangement described above for moving the light-directing means, it may be seen that the geographical location of a body may be indicated automatically and continuously on the translucent map. By providing a light sensitive film in place of or in conjunction with the map, the course followed by a mobile body may be permanently charted and recorded. It will be appreciated that it is not necessary for the light spot 60 to trace actual hyperbolic curves 39 and 40 since there will be only one position of the light spot for any one position of the body. Hence, the screen 58 may be provided with scale markings which may be referred to a map, or a distorted map or translucent screen may be provided.

It is not necessary to provide any fixed positions of radiation to obtain the advantages of this invention. For example, radiator 7 of Fig. 1 may be located on a moving body, as on an airplane, and receiver 9 and transmitter 1 may be located on a second mobile body, in which case the distance between the bodies may be readily determined and if desired the two bodies may maintain a given separation in accordance with the phase angle indication obtained from indicator 18. Under such circumstances it may be desirable to modulate the transmitter 1 with a comparatively high frequency so that a relatively close separation between the two sets of transmitters and receivers may be maintained.

The method and apparatus of this invention are subject to considerable modification without departing from the spirit of this invention, hence I do not choose to be restricted to the non-limitative examples described, but rather to the scope of the appended claims.

I claim:

1. The method of determining the location of a mobile body, which comprises: radiating a carrier wave from a fixed known location spaced from said body; radiating a carrier wave from said body; impressing a modulation frequency on one of said carrier waves; receiving said one

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modulated carrier wave adjacent the position of radiation of the other of said carrier waves; demodulating said received wave; impressing the modulation resulting from demodulating said received wave on said other carrier wave; receiving said modulated other carrier wave at a position adjacent the position of radiation of said one modulated carrier wave; demodulating said last-named received modulated carrier wave; comparing the phase relation between the modulation received from the last-mentioned demodulating step and the modulation impressed on said one carrier wave; and varying the frequency of the modulation impressed on said one carrier wave to produce a given value of said phase relation.

2. The method of determining the location of a mobile body, which comprises: radiating a carrier wave from a fixed known location spaced from said body; radiating a carrier wave from said body; impressing a modulation frequency on one of said carrier waves; receiving said one modulated carrier wave adjacent the position of radiation of the other of said carrier waves; demodulating said received wave; impressing the modulation resulting from demodulating said received wave on said other carrier wave; receiving said modulated other carrier wave at a position adjacent the position of radiation of said one modulated carrier wave; demodulating said last-named received modulated carrier wave; and comparing the phase relation between the modulation received from the last-mentioned demodulating step and the modulation impressed on said one carrier wave.

3. The method of determining the location of a mobile body which comprises: radiating carriers of the same frequency from a pair of radiators which are spaced a number of carrier wavelengths from one another in fixed known locations; modulating one of said carriers with one modulation frequency and the other of said carriers with a different modulation frequency having a given phase relation to said one modulation frequency, said modulation frequencies being integral multiples of a given modulation frequency, receiving said radiated modulated carriers on said mobile body; demodulating said received carriers; separating the two modulation frequencies obtained from said demodulating step; multiplying at least one of said separated modulation frequencies to obtain two separate modulations of the same frequency from the two different separated modulation frequencies; and comparing the phase relation between said two separate modulations of the same frequency.

4. An apparatus for use in determining the location of a mobile body, which comprises: radiating means for radiating a carrier wave from a known fixed location spaced a number of carrier wavelengths from said body; radiating means carried by said body for radiating a carrier wave from said body; a first modulator located adjacent one of said radiating means for modulating the carrier radiated from said one radiating means; means associated with the other of said radiating means for receiving and demodulating said one modulated carrier wave; a second modulator for modulating said other radiated carrier by the modulations received from said receiving and demodulating means; means associated with said one radiating means for receiving and demodulating said other radiated modulated carrier wave; and phase angle responsive means associated with said last-named receiving and demodulating means and with said first modulator for comparing the phase relation between the modulation supplied to said one carrier wave and the modulation received by said last-named receiving and demodulating means.

5. An apparatus for use in determining the location of a mobile body, which comprises: radiating means for radiating a carrier wave from a known fixed location spaced a number of carrier wavelengths from said body; radiating means carried by said body for radiating a carrier wave from said body; a first modulator located adjacent one of said radiating means for modulating the carrier radiated from said one radiating means; means associated with the other of said radiating means for receiving and demodulating said one modulated carrier wave; a second modulator for modulating said other radiated carrier by the modulations received from said receiving and demodulating means; means associated with said one radiating means for receiving and demodulating said other radiated modulated carrier wave; phase angle responsive means associated with said last-named receiving and demodulating means and with said first modulator for comparing the phase relation between the modulation supplied to said one carrier wave and the modulation received by said last-named receiving and demodulating means; and means for varying said modulation frequency to produce a given value of comparison on said phase angle responsive means.

6. An apparatus for use in determining the location of a mobile body, which comprises: means for radiating carrier waves of the same frequency from a pair of widely spaced radiators which are located in fixed known locations; means for modulating each of said carriers with a different modulation frequency and in a given phase relation, said modulation frequencies being integral multiples of a given modulation frequency; receiving means carried by said body for receiving and demodulating both of said modulated carriers; means associated with said receiving means for separating said two received modulations and for multiplying at least one of said separated received modulations to thereby produce two separated modulations of the same frequency from the separated modulations of different frequency; and means carried on said body for comparing the phase relation between the two separated received modulations of the same frequency.

7. In a radio navigation apparatus for determining the location of a body, the combination which comprises: transmitting apparatus having two sources of different frequency carrier waves; means including a source of relatively low frequency oscillation for respectively modulating the carrier waves of the first named sources; a pair of modulation systems for superimposing the low frequency oscillation upon each of the carrier waves; phase shifting means for producing a given phase relation of the modulation as applied to the two carrier waves from the first named sources; a pair of non-directional vertical radiators for separately radiating the modulated carrier waves; and receiving apparatus carried on said body for separately and simultaneously amplifying and demodulating the modulated carrier waves received from the two radiators, including means for applying the received space phase displaced modulation waves to a phase angle indicator, whereby the differ-

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ence of the distances to said body from each radiator is indicated.

8. In an apparatus for determining the location of a body, the combination which comprises: transmitting apparatus having sources of carrier waves of a given frequency with two spaced non-directional radiators for simultaneously radiating said carrier waves of the same given frequency; a source of relatively low frequency oscillations; a frequency multiplier connected therewith for multiplying said oscillations; a pair of modulation systems for superimposing the relatively low frequency oscillations upon the carrier waves radiated from one radiator and the multiplied low frequency oscillations upon the carrier waves radiated from the other radiator; phase shifting means for producing a given phase relation between the modulating oscillations as radiated from the respective radiators; receiving apparatus carried on said body for simultaneously receiving, amplifying and demodulating the two modulation frequency differentiated carrier waves from the respective radiators, including means for applying the two different modulating oscillations as received to two filter networks in which one of said networks is responsive to the relatively low frequency oscillations and the other responsive to the multiplied low frequency oscillations; a frequency multiplier connected to multiply the relatively low frequency oscillations, as filtered, by an amount equal to the multiplication of the frequency multiplier first named; and means for applying the two filtered multiplied oscillations in the same relation as received to a phase angle indicator, whereby the location of the receiving apparatus with respect to the radiators is indicated.

9. In an apparatus in accordance with claim 8, the frequency of the multiplied low frequency oscillation being such that one-quarter of its electrical wavelength is not less than the distance between the spaced non-directional radiators.

10. In an apparatus for use in determining the location of a body, in which modulated carrier waves are radiated from at least three angularly spaced radiators and said modulated waves are received in receiving means provided on said body, the combination which comprises: a light source providing a light beam; a screen; light-directing means mounted for angular rotation about two mutually transverse axes to direct the light beam onto said screen; means for moving said directing means about one of said axes in response to changes in the phase displacement between the modulations received from one pair of said radiators; and means for moving said directing means about the other of said axes in response to changes in the phase displacement between the modulation received from another pair of said radiators.

11. In an apparatus for use in determining the location of a body, in which modulated carrier waves are radiated from at least three angularly spaced radiators and said modulated waves are received in receiving means provided on said body, the combination which comprises: a light source providing a light beam; a screen; light-directing means mounted for angular rotation about two mutually transverse axes to direct the light beam onto said screen; and means for moving said directing means about at least one of said axes in response to changes in the phase displacement between the modulations received from one pair of said radiators.

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July 8, 1941. H. M. STROBEL **2,248,727**

SIGNALING SYSTEM

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Fig.1.

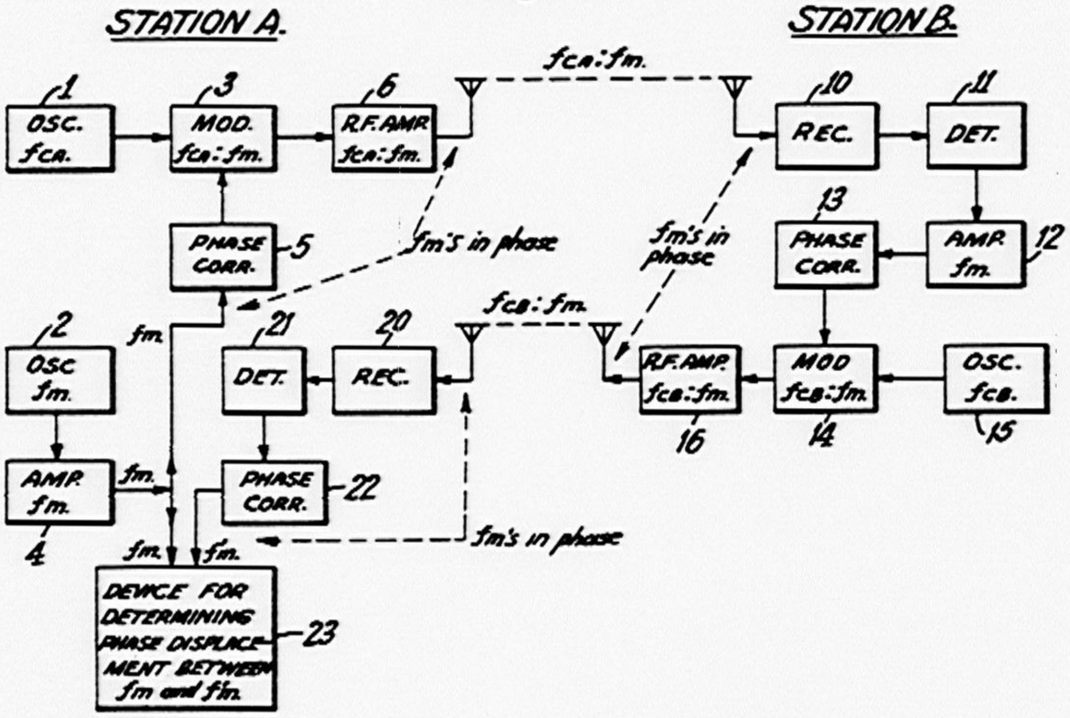


Fig.4.

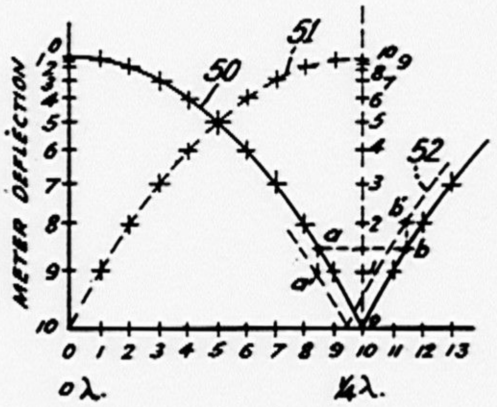
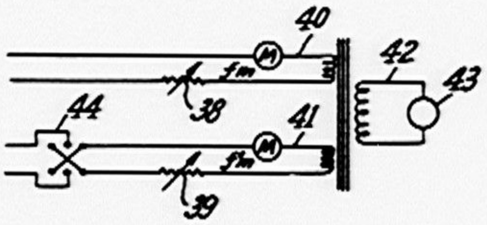


Fig.3.



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SIGNALING SYSTEM

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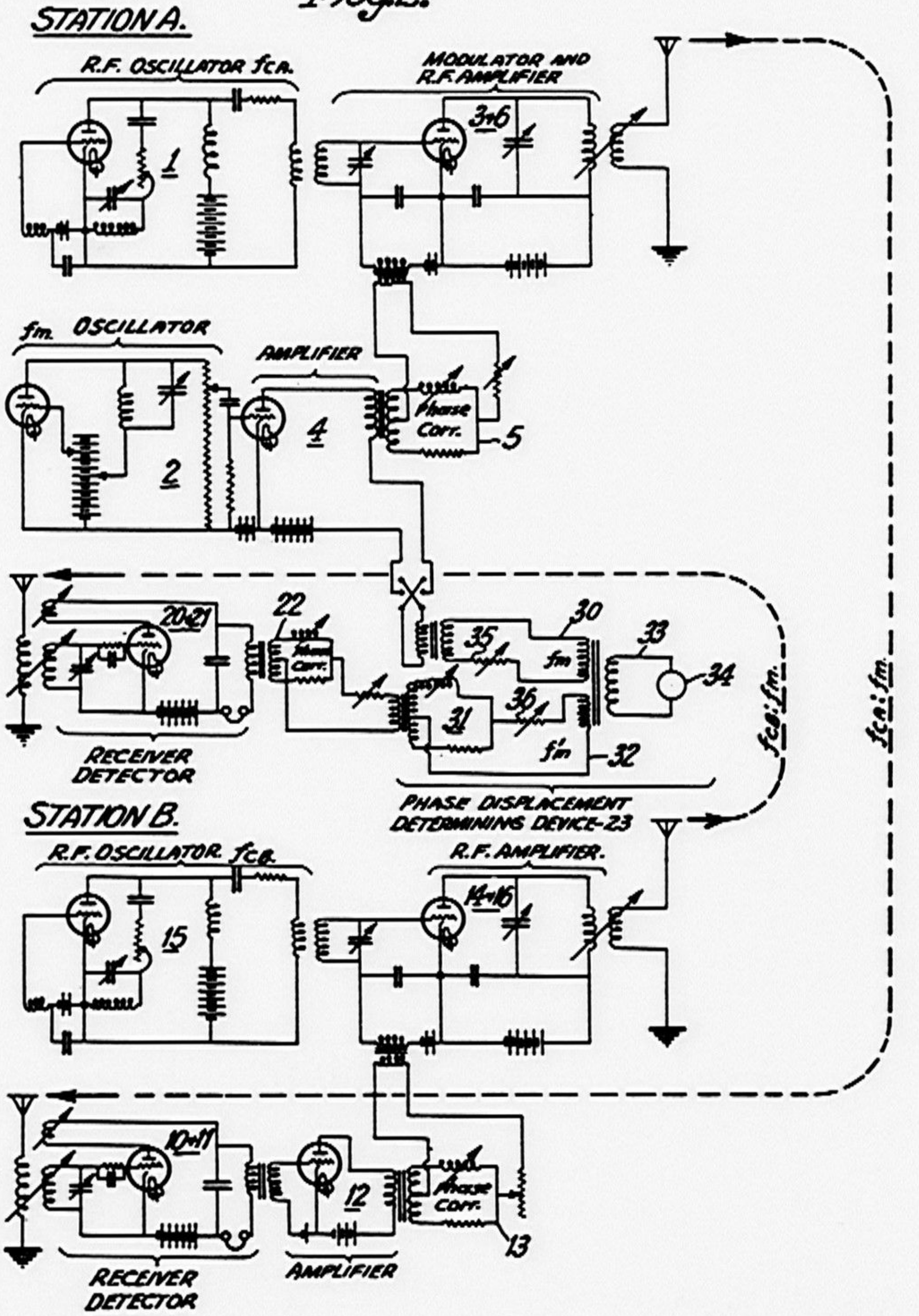
Fig.2.



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SIGNALING SYSTEM

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Fig. 5.

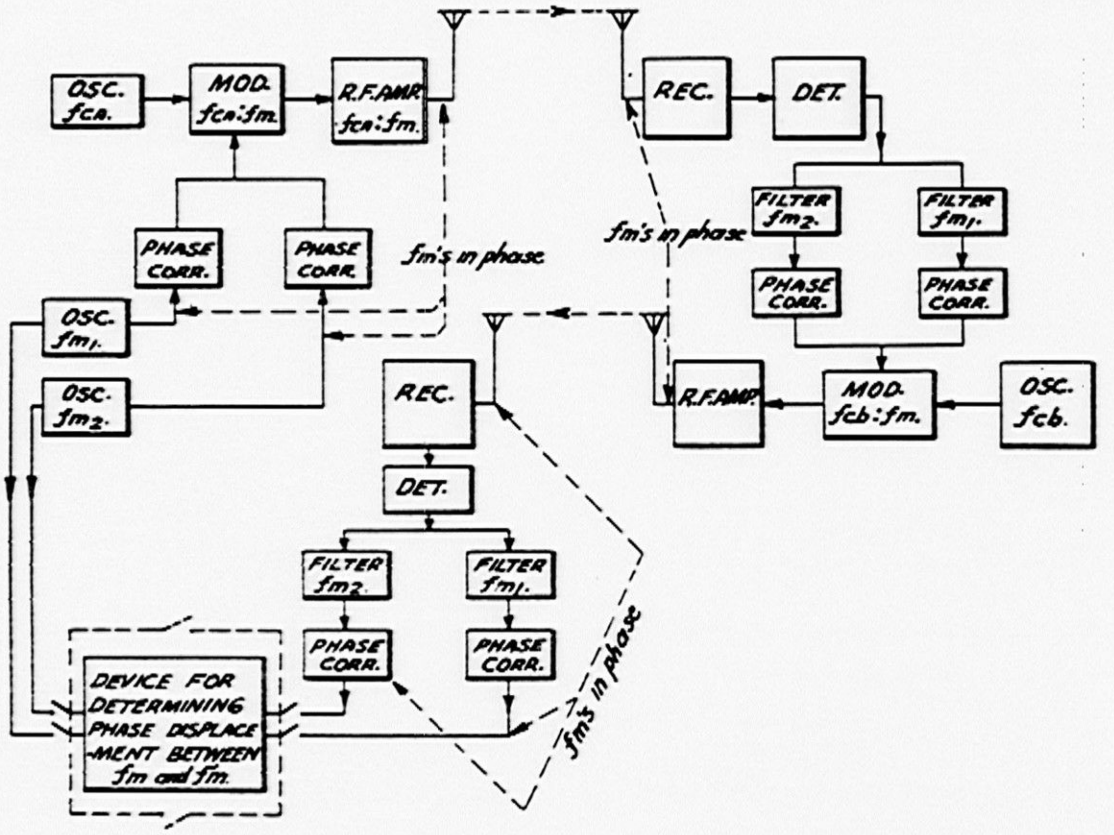
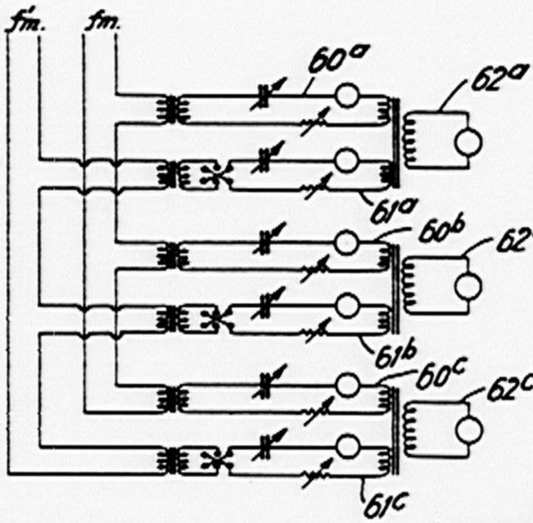


Fig 6.



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UNITED STATES PATENT OFFICE

2,248,727

SIGNALING SYSTEM

Howard M. Strobel, Allegany, N. Y.

Application December 9, 1939, Serial No. 308,338

7 Claims. (Cl. 250—2)

This invention relates to signaling systems, and particularly to a system employing radiation of known wave length as the means by which intelligence is transferred from one station to another.

The object of the invention is to provide improved apparatus and method for determining at a first or primary station, the distance of a second or secondary station from the primary station. Another object is to make such determinations with any desired degree of precision; and a third object is to make them with great rapidity.

It is known to measure distances, for example the distance of an airplane above the ground, by transmitting an electromagnetic wave to the ground, where it is reflected back to its source, the airplane, receiving it again at the airplane and measuring the total elapsed transmission time. In view of the constancy of the velocity of propagation of electromagnetic radiation, the time elapsed between the transmission and the reception is a measure of the distance from the airplane to the ground.

This system does not lend itself to the measurement of great distances, particularly horizontal distances of ships at sea for example. The attenuation of the wave over its transmission path to the reflector and back, is so great in the case of large distances that when the signal is finally received after reflection it may be immeasurably weak. Furthermore, the results depend intimately upon the size and shape of the reflector, which is adequate in the case of the ground, acting as a reflector for an airplane, but inadequate in the case of a ship at sea. In addition, radio waves are more severely attenuated when travelling horizontally than when travelling vertically.

Subsidiary objects of the invention are to overcome the above-named difficulties.

I accomplish these and other objects by transmitting from the first or primary station, termed "station A" a signal of precisely known frequency and phase in the form of an electromagnetic wave; by receiving this signal at a secondary station, termed "station B," and there amplifying and retransmitting it, unaltered in frequency or phase; and lastly by receiving this retransmitted signal at the primary station and comparing its phase as finally received with its phase as originally transmitted. I am able to translate the result of this comparison into a determination of the distance separating the secondary station from the primary station in a manner which will be clear from what follows, with any desired degree of accuracy and with great speed.

In order the better to transmit my signal wave from the primary station, I prefer to modulate it onto a high frequency carrier which, as is well known, may be propagated for great distances. At the secondary station this modulated carrier is received and demodulated to provide the signal wave. The latter is then amplified and modulated onto another carrier which is transmitted from the secondary station to the primary station. At the primary station this new modulated carrier is received and demodulated to give once more the signal wave. Thus the carrier wave and the detection apparatus are of assistance in the propagation of the signal but do not constitute essential features of the measurement system.

When a carrier is employed I prefer to choose the frequency of the carrier transmitted from the secondary station different from the frequency of the carrier transmitted from the primary station. This choice of different frequencies greatly simplifies my apparatus since, if they were the same, it would be necessary to exercise the greatest precautions to prevent each station from receiving the carrier transmitted by itself, thus masking the weaker carrier received from the distant station.

More particularly, the invention consists in the system and method hereinafter described, illustrated in the accompanying drawings and defined in the claims hereto appended, it being understood that various changes in form, arrangement and details both of circuits and of method within the scope of the claims may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

For a clearer comprehension of the invention reference is directed to the accompanying drawings which illustrate a preferred embodiment thereof, wherein:

Fig. 1 is a block diagram of a prefered embodiment of my system, showing the component devices at the primary station (station A), including a phase displacement measuring device, and the component devices at the secondary station (station B);

Fig. 2 shows the essential circuit elements and details of the system schematically shown in Fig. 1;

Fig. 3 is a circuit diagram illustrating an alternative arrangement of phase displacement measuring apparatus;

Fig. 4 is a diagram illustrating the mode in which phase indications of the apparatus of Fig. 3 are interpreted as measurements of the distance of separation of stations A and B;

Fig. 5 is a block diagram similar to that of Fig. 1, but showing a modified system adapted for simultaneous transmission and reception of a plurality of signals; and

Fig. 6 is a modification of the circuit diagram of Fig. 3, appropriate for use with the modified system of Fig. 5.

The system of my invention and the manner in which it operates will be best understood from a consideration of the block diagram, Fig. 1. At station A an oscillator 1 generates a high frequency carrier designated by the symbol "f_{ca}"; and another oscillator 2 generates the modulating signal designated by "f_m." The carrier f_{ca} is fed directly to a modulator 3 and the signal f_m is fed to the same modulator 3 through an amplifier 4 and a phase correcting device 5. The modulator 3 combines the modulating signal f_m with the carrier in the well known manner and the resultant compound wave is fed to a radio frequency amplifier 6 for amplification. It is then transmitted to station B, the transmission path being indicated by a dashed line connecting station A with station B and the modulated signal transmitted over this path is indicated by the symbol "$f_{ca}:f_m$."

Any desired form of modulation may be utilized, since the carrier, f_{ca} is employed only to carry the modulating signal f_m from station A to station B, the invention residing in the treatment of the modulating signal f_m and in the modulation thereof onto any appropriate carrier.

At station B the compound wave $f_{ca}:f_m$ is received in a receiver 10 and demodulated by a detector 11 to obtain the original signal f_m. This signal f_m is next increased in strength by an amplifier 12 and then passed through a phase correcting device 13 to the station B modulator 14 into which is also fed a high frequency carrier designated by the symbol "f_{cb}" generated by an oscillator 15 at station B. In the modulator 14 the signal f_m is modulated onto the carrier f_{cb} and the resultant is amplified by an amplifier 16 and transmitted in the form of a compound wave, conveniently designated as "$f_{cb}:f_m$."

This new compound wave, $f_{cb}:f_m$ is received by a receiver 20 at station A and demodulated by a detector 21 to obtain the original signal f_m, which is then passed through a phase correcting device 22. This original signal, although its frequency has not been changed, will have undergone a substantial phase shift. It is therefore designated, for convenience, by the symbol "f_m^1" to distinguish it from f_m, by which it was originally designated.

This received signal f_m^1, is now fed to a phase displacement determining device 23 and the signal f_m as originally generated at station A by the oscillator 2 is fed to the same phase displacement determining device 23 at the same time. This device 23 may be of any kind which serves the desired purpose, namely of determining the phase displacement between f_m and f_m^1.

This phase displacement depends on a number of things: the modulating, amplifying and transmitting apparatus of station A; the distance of transmission between station A and station B; the receiving, demodulating, modulating and transmitting apparatus at station B; and the receiving and demodulating apparatus at station A. However, this effect on phase of each part of the apparatus may be discovered and corrected. It is for this purpose that the three phase correction devices 5, 13, 22, each of which is known per se, are included in the system. The first, 5, adjusts to zero the phase displacement between the signal as originally generated and as ultimately transmitted with the carrier f_{ca} from station A. The second, 13, at station B, adjusts to zero the sum of all the phase displacements in the apparatus of station B so that the signal as ultimately retransmitted from station B is in phase with the signal as originally received at station B. The third, 22, adjusts to zero the phase displacement between the signal as initially received at station A and as fed, designated as f_m^1, to the phase displacement device 23.

When all the phase displacements due to the apparatus are corrected to zero the remaining phase displacement between f_m and f_m^1, which may be designated as the "propagation phase displacement," depends solely on the total distance of transmission from station A to station B and return, and therefore provides an indication of this distance. For example, if the propagation phase displacement is just 180°, it is known that the distance of transmission is just one-half of the wave length corresponding to the frequency f_m and therefore that the distance of separation of stations A and B is just one-quarter of this wave length.

It will be apparent that the phase correcting devices 5, 13, 22 are conveniences in the system rather than essentials. When the phase displacements in the apparatus are corrected to zero the ultimate phase displacement between f_m and f_m^1 gives the distance of separation of the stations directly without the necessity of corrections; but if desired, the phase correcting devices 5, 13, 22 may be dispensed with and instead, the phase displacement due to both transmissions may be determined by subtracting from the total phase displacement the phase displacements due to the apparatus, which in this case must of course be precisely known.

Fig. 2 is a wiring diagram of preferred circuit arrangements for the system of my invention. The various devices at stations A and B are numbered and labelled correspondingly with the blocks of Fig. 1, except that a single device is shown as performing the functions of modulation and R. F. amplification in both stations and another single device is shown as performing the functions of receiving and detecting in both stations. The various component parts such as vacuum tubes, condensers, inductances, batteries, resistors and the like are indicated by conventional symbols. The transmission paths from station A to station B and the return path from station B to station A are indicated by the heavy dashed lines.

Fig. 2 shows the details of a simple phase displacement measuring device 23. It includes a transformer having three windings, two input windings and one output winding. The signal f_m is supplied directly to one of the input windings 30, 32 and the signal f_m^1 is supplied through a calibrated phase shifter 31 to the other winding 32. The output winding 33 is connected to a meter 34 which may be of any appropriate type. In operation the phase shifter 31 is manually adjusted until the meter reading is zero, indicating that the voltages in the two primary windings 30, 32 are opposed; or a maximum, indicating that these voltages are aiding. The dial of the phase shifter 31 which may conveniently be calibrated in fractions of a wave length, is then read. When the frequency and wave length of

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f_m are known, the distance of separation of the stations may at once be computed.

In order that there may be precision in the results it is essential that the frequency f_m be constant and be accurately known. Devices such as the crystal-controlled oscillator for holding the frequency of oscillation to a constant value are well known in the art.

In actual practice, the minimum deflection of the meter is sharper than the maximum, and I therefore prefer to shift the phase of f_m^1 until minimum meter deflection is obtained. Of course, in order that there shall be any minimum the voltages on the two primary windings should be alike in magnitude and any desired means may be employed to accomplish this result. I have shown as one such means a variable resistance **35**, **36** in series with each winding **30**, **32**.

As above stated, a phase shift of 180° corresponds to a total transmission distance of one-half wave length. Similarly a phase displacement of 360° corresponds to a total transmission distance of a full wave length or a separation distance between stations of one-half wave length. Greater distances of separation will correspond to phase displacements of more than 360°, which in the case of known phase measuring devices are indistinguishable from phase shifts of lesser amounts; for example a phase shift of 400° is indistinguishable from a phase shift of 40°. Thus a unique determination of distances is obtainable only for station separations up to one half the wave length.

As an illustration, suppose that a modulation frequency of 1500 C. P. S. is chosen, corresponding to a wave length of 200 km. The same amount of phase shift would be obtained for a number of stations B, each separated from the next by a half wave length or 100 km. Suppose that the phase shift indication is 180°. This means that the station separation distance may be any one of the fractions ¼. ¾. 5/4. 7/4 etc. of the wave length and unless the distance be approximately known, the measurement is substantially useless.

The distance may be approximately known by the simple expedient of using a lower modulation frequency. For example, if a frequency of 150 C. P. S. be used, the full wave length is 2000 km. and distances up to one-half of this or 1000 km. can be measured before phase displacement values begin to repeat. If for example, station B is 970 km. distant from station A the phase shift reading on the low frequency of 150 C. P. S. will be about 349°. Greater precision of measurement may now be obtained by changing the frequency of f_m, for example to a frequency 10 times as high, 1500 C. P. S., whereupon the full transmission path will be 9 full wave lengths and $\frac{7}{10}$ of a wave length, and the phase shift reading will be 252°, with a precision 10 times as great as that given by the low frequency measurement.

Similarly, still greater precision may be obtained by using a still higher frequency, for example, 15,000 C. P. S., corresponding to a full wave length of 20 km. or a separation distance of 10 km. or less.

The above-described apparatus is simple and the method of utilizing it to make measurements of distance is precise. However, when station B is a moving object such as a ship at sea whose distance it is important to know at all times, it may be desirable to have a continuous indication of such distance. This may be accomplished by a slight alteration in the above-described apparatus illustrated in Fig. 3. In this figure the signals f_m and f_m^1 are adjusted to equal standard magnitudes by resistors **38**, **39** and are then impressed on two input windings **40**, **41**, of a transformer without the interposition of any phase shifting device, and an output winding **42** feeds a meter **43** which is directly calibrated in fractions of a wave length for this standard. A station separation distance of ¼ wave length corresponds as above described to a phase displacement of 180° and therefore to a meter reading of zero as indicated on the diagram Fig. 4. Any less separation distance corresponds to a less phase displacement and therefore to a positive meter reading, until at distances so short that they correspond to an insubstantial fraction of a wave length, the meter deflects to substantially its full scale reading.

As shown by the solid curve **50**, and the left hand ordinate scale, Fig. 4, the precision is greatest for distances in the neighborhood of ¼ wave length and least at very small fractions of a wave length. For example, a distance of 0.8 of a quarter wave length may be measured with far more accuracy than a distance of 0.2 of the same quarter wave length. To overcome this objection I simply provide a reversing switch **44** (Fig. 3) in the circuit of f_m^1. It might be provided in the circuit of f_m equally well. When this switch **44** is thrown, the dashed curve **51** of Fig. 4, and the right hand dashed ordinate scale are substituted for the solid curve **50** and the precision conditions reversed, so that now the smaller distances may be measured precisely.

When the meter reading is in the neighborhood of zero it may be that the operator will not know whether it corresponds to the point *a* or to the point *b* on the solid curve **50** of Fig. 4. He may easily discover this by slightly shifting the frequency f_m. If for example he makes a frequency shift which corresponds to a decrease in wave length of 5% the effect on the meter readings will be as indicated by the dotted line **52** in Fig. 4. If the reading was at *a*, the new reading will be less. If it was at *b*, the new reading will be greater.

As before, particularly in the case of great distances, greater precision may be obtained by using a higher signal frequency, for example a frequency 10 times as high. For example, choosing 75 C. P. S. as the signal frequency, the wave length is 4000 km. and zero deflection of the meter corresponds to a separation distance of a quarter wave length or 1000 km. With 10 divisions on the dial, each division represents 100 km. Then, if for example, the meter reads some value between 3 and 4 the operator would know that the separation distance between stations was between 300 and 400 km. He could then raise the signal frequency to 750 C. P. S., for example, giving a measuring unit of 100 km., whereupon each of the 10 divisions will represent 10 km. and the full range of the meter scale would apply to the region between 300 and 400 km. separation, thus giving 10 times the precision of the earlier measurement.

For continuous indications which may be interpreted with the greatest rapidity it may be desirable to make the low frequency reading and the high frequency reading simultaneously. This may be accomplished, as indicated in Fig. 5, by simultaneously generating at station A two or more signals of accurately known frequency, for example 75 C. P. S., 750 C. P. S. and 7500 C. P. S. These may then be modulated together on the carrier f_m, transmitted to station B, returned by station B and received and demodulated at station A and fed to the phase displacement measuring device, all in the same manner as one. They must eventually be separated, and a convenient manner of accomplishing this separation is illustrated in Fig. 6, where three pairs of tuned circuits 60, 61 are shown, each operating its own meter 62. Both members of one pair are of course tuned to one signal frequency, for example, 75 C. P. S., both members of the second pair to another signal frequency, for example, 750 C. P. S., and both members of the third pair to still another, for example, 7500 C. P. S. Tuned circuits and meters may be duplicated as much as desired.

It is of course necessary in the case of the simultaneous transmission of two or more modulating frequencies that each of them be properly corrected for phase at the station A transmitter, at station B, and at the station A receiver. In case any of this apparatus is of a character to cause different phase shifts in the different signal frequencies, separate phase corrections must be applied. This can be done in a well known manner by separating the components through filters and passing them through separate phase correction devices and ultimately recombining them. This separation and recombination are likewise indicated in Fig. 5.

Though I conceive that my system will have its chief utility in determining the distance between ships at sea or between a ship and the shore it is, of course, not limited to this use but may be of utility in determining the distance of an airplane from a landing field, or its altitude, or both. Obviously it may, if desired, easily be applied to determining the distance between fixed points on land. Furthermore the wireless link is not an essential. Any form of wave propagation will serve, as long as the velocity of propagation is definitely known.

Due to variations in the medium through which a wave might be propagated, the velocity of the wave propagation may not be a definite known constant. In the case of radio waves propagated through air, for example, variations in air pressure humidity and ionization may alter the velocity of propagation, and hence likewise any distance measurement premised thereon. A distance measuring primary station may be corrected for such errors by using an auxiliary secondary station located some measured fixed distance from the primary station. Using carrier frequencies that will not interfere with the main working frequencies of the primary station, the measured distance off of the auxiliary secondary station from the primary station can be used to monitor the modulating frequency of the primary station oscillator. Monitoring may be accomplished in one of two ways: One is by varying the modulating frequency of the oscillator until the indicating meter (which is, say, calibrated in units of distance) also indicates the correct known distance, and the second way is to maintain the modulating frequency constant and use the value given by the indicating meter (which will be in error when changes in the velocity of the propagated wave occur) to determine the correction factor that must be applied to any indicated readings. In this way, when the primary station takes a distance measurement on some mobile station an unknown distance away, assuming that the atmospheric conditions are the same throughout the length of path as exist at the primary station, then the modulating frequency or correction factor determined by the use of the auxiliary secondary station can be used to correct the indicated distance measurement.

It will be plain to those skilled in the art that my invention can equally be applied to the determination of propagation velocity when distance and frequency are known, or to the determination of frequency when distance and velocity are known.

I claim:

1. The method of measuring distance which comprises simultaneously transmitting a plurality of signals of preassigned constant frequency from a primary station, said signals differing in frequency by successive multiples of ten of the lowest fundamental signal frequency of the group, receiving said signals at a secondary station, amplifying and retransmitting said signals from said secondary station, receiving said signals at said primary station, adjusting to known values all phase displacements of each of said signals due to translation of said signals through apparatus, determining the total phase displacement between each of said signals as originally transmitted from said primary station and as ultimately received thereat, and determining the propagation phase displacement for each of said signals by subtracting from said total phase displacement determination said apparatus phase displacements.

2. The method of measuring distance which comprises modulating a carrier with a plurality of signals each of preassigned constant frequency, at a primary station, to provide a compound wave, said signals differing in frequency by successive multiples of ten of the lowest fundamental signal frequency of the group, transmitting said compound wave to a secondary station, receiving and demodulating said compound wave at said secondary station to obtain said signals, modulating another carrier with said signals to provide another compound wave and transmitting said other compound wave to the primary station, receiving and demodulating said other compound wave at said primary station to obtain said signals, adjusting to known values all phase displacements of each of said signals due to translation of said signals through apparatus, determining the phase displacement between said signals as initially transmitted from said primary station and as finally received thereat and determining the propagation phase displacement of each of said signals by subtracting from said total phase displacement determination said apparatus phase displacements.

3. In a distance measuring system, the combination of means at a primary station for generating a plurality of signals of preassigned constant frequency, said signals differing in frequency by successive multiples of ten of the lowest fundamental signal frequency of the group, means at said primary station for transmitting said signals with a first carrier to a secondary station, means at said secondary station for receiving said carrier and signals and retransmitting the signals with a second carrier to the primary station, said second carrier differing from said first carrier, means at the primary station for receiving said second carrier and signals and for separating said signals from said second carrier, means for adjusting to known values phase shifts of each of said signals due to translation of said signals through appara-

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tus, and means at the primary station for determining the propagation phase displacement between each of the signals as originally transmitted and as ultimately received.

4. In a distance measuring system, the combination of means at a primary station for generating a plurality of signals of preassigned constant frequency, said signals differing in frequency by successive multiples of ten of the lowest fundamental signal frequency of the group, means at said primary station for transmitting said signals with a first carrier to a secondary station, means at said secondary station for receiving said carrier and signals and retransmitting the signals with a second carrier to the primary station without alteration of frequency or phase of any of said signals, said second carrier differing from said first carrier, means at the primary station for receiving said second carrier and signals and for separating said signals from said second carrier, and means at the primary station for determining the phase displacement in decimal parts of a wave length unit between each of said signals as originally transmitted and as ultimately received.

5. The method of determining the velocity of a wave in terms of a constant frequency and a known constant length of path which comprises transmitting a signal of preassigned frequency and phase from a primary station, receiving said signal at a secondary station, said secondary station being a known constant distance from said primary station, retransmitting said signal from said secondary station, receiving the retransmitted signal at said primary station, adjusting to known values all phase displacements of said signal due to translation of said signal through apparatus, determining the total phase displacement between the signal as originally transmitted from said primary station and as ultimately received thereat, and from the difference of said total phase displacement and said apparatus phase displacements determining the propagation phase displacement.

6. In a signaling system for determining the velocity of a wave in terms of a signal wave having a known constant frequency and traversing a known constant length of path, the combination of means at a primary station for generating a signal of preassigned frequency and phase, means at said primary station for transmitting said signal with a first carrier to a secondary station, the distance between said primary and said secondary station being a known and fixed value, means at the secondary station for receiving said carrier and signal and for retransmitting the signal with a second carrier to the primary station, means at the primary station for receiving said second carrier and retransmitted signal and for separating said signal from said second carrier, with means at each of said stations for adjusting to known values any apparatus phase shift introduced into said signal due to any of said translating apparatus, and means at the primary station for determining the propagation phase displacement between the signal as originally transmitted and as ultimately received.

7. In a signaling system for indicating the distance between a primary and a secondary station in decimal parts of a fundamental wave length simultaneously to at least two significant figures, the combination of means at a primary station for generating simultaneously a plurality of signals of preassigned constant frequency and phase, said plurality of signals differing in frequency by successive multiples of ten of the lowest fundamental signal frequency of the group, means at said primary station for transmitting said signals with a first carrier to a secondary station, means at said secondary station for receiving said carrier and signals and retransmitting the signals with a second carrier to the primary station, means at the primary station for receiving said second carrier and retransmitted signals and for separating said signals from said second carrier, means for adjusting to known values, phase shifts of said signals due to translation of said signals through apparatus at said stations, and means at the primary station for simultaneously indicating the propagation phase displacement in decimal parts of a wave length unit between each of the signals as originally transmitted and as ultimately received.

HOWARD M. STROBEL.

Jan. 17, 1939. J. P. SHANKLIN **2,144,203**

METHOD FOR DIRECT INDICATION OF POSITION IN A GIVEN AREA

Filed Sept. 23, 1937

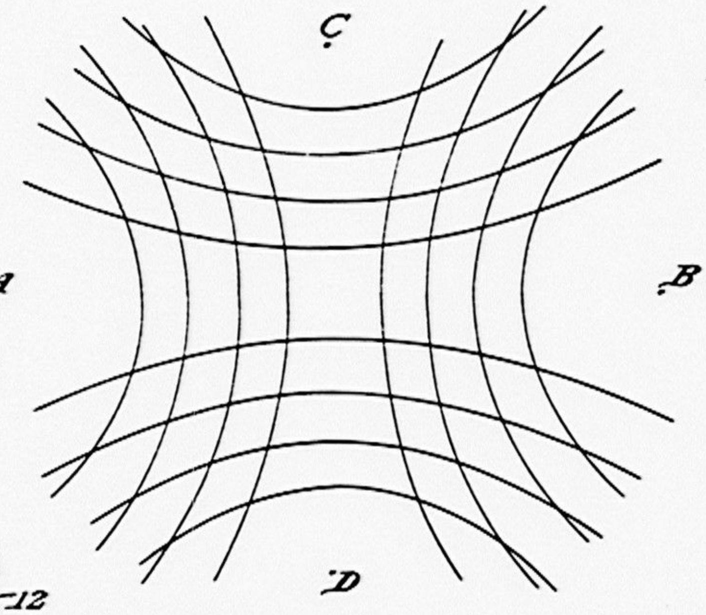

Fig. 1.

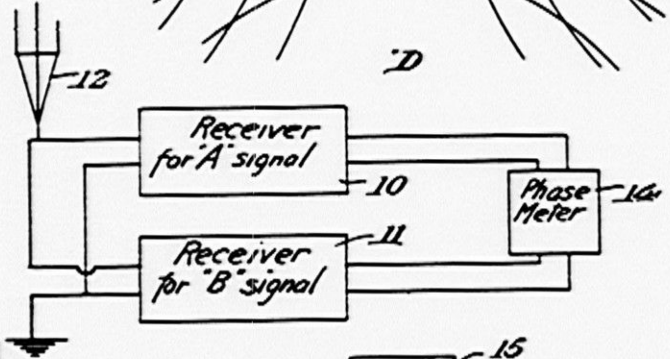

Fig. 2.

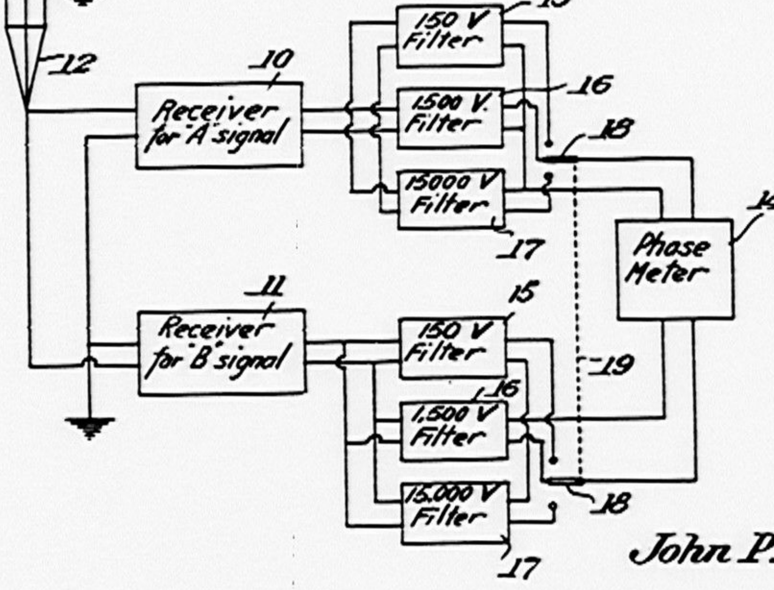

Fig. 3.

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Patented Jan. 17, 1939 **2,144,203**

UNITED STATES PATENT OFFICE

2,144,203

METHOD FOR DIRECT INDICATION OF POSITION IN A GIVEN AREA

John P. Shanklin, Marion, Va.

Application September 23, 1937, Serial No. 165,404

5 Claims. (Cl. 250—11)

The object of the invention is to provide a method that makes possible, by direct reading, one's position in a given area; to provide a method of the kind indicated that will give such location of position whether the observation be made while the user is in motion or at rest; and to provide a method for direct indication of position that makes use only of conventional apparatus, or equipment, so that its application may be carried out with a minimum of expense.

With this object in view, the invention consists in a certain arrangement and employment of certain apparatus which are graphically illustrated in the accompanying drawing, wherein:

Figure 1 is a view graphically illustrating an area so controlled that by the use of conventional receiving and measuring apparatus one's position therein may be readily indicated.

Figure 2 is a graphical illustration of the receiving equipment.

Figure 3 is a similar view showing receiving equipment more refined than in Figure 2.

In carrying out the invention, transmitters are positioned at the points A and B of the controlled area and these transmitters will operate on any desired fundamental frequency. The distance between the transmitters at A and B is arbitrarily assumed to be 1,000 kilometers, since the invention can be best understood if described in connection with fixed distances.

Impressed on the fundamental frequencies of the transmitters, there is a modulation frequency whose wave length is directly proportional to the distance between the stations or transmitters. Since this distance is 1,000 kilometers, the modulation frequency had best be 150 cycles, since the wave length at this frequency is 2,000 kilometers. But the modulation frequencies are synchronized, which may be accomplished by reference to any stardard frequency or by land lines, as clearly set out in Patent No. 1,942,262. With the modulation frequencies synchronized, the modulation tone from the station A will reach the station B one-half a cycle after it has left the station A. Similarly, the modulation tone from the station B will reach the station A one-half a cycle after it has left the station B. The two are, therefore, 180 degrees out-of-phase at the stations or transmitters A and B with their polarities respectively reversed, but in phase at midpoint between the stations or transmitters.

To take advantage of this condition, any translational means employed for translation over the controlled area is equipped preferably with the receivers 10 and 11 to be tuned respectively to the signals issuing from the transmitters at the stations A and B, the intake of the receivers being connected to a common antenna 12 carried by the translational means. The outputs of the receivers, however, are connected to a phase meter 14 whose indicator swings to either side of its normal centrally disposed zero position, so that when the signal from the transmitter A is leading, the indicator will swing in one direction, but in the other direction when the signal from the transmitter or station B is leading.

As the translational means progresses, therefore, if the receivers 10 and 11 are tuned to their respective stations or transmitters, the phase relation of the modulated signals will be shown by the phase meter, whose indicator will swing from one end of the scale to the other, standing in the zero or middle position at midpoint between the stations by reason of the modulation frequencies being in phase at this point. The translational means may be either moving or at rest, the phase meter indicating changing position if moving, but directly indicating the point of location of the translational means if the reading be taken while the latter is at rest.

If, in addition to the one modulation frequency impressed on the carrier wave, there be also impressed additional synchronized frequencies, as for example 1,500 cycles and 15,000 cycles, greater accuracy in location of position will be obtained. The synchronized frequencies are in geometrical progression, of which the common multiplier is ten, so that on the assumed distance between stations or transmitters, the waves of 1,500 cycle frequency will fall into phase ten times and the waves of 15,000 frequency 100 times.

Where multiple modulation frequencies are employed, the receivers 10 and 11 will be connected to the phase meter 14 through the filters 15, 16 and 17, respectively, for the 150 cycle frequency, the 1,500 cycle frequency, and the 15,000 cycle frequency, but through single-pole triple-throw switches 18 which are interconnected, as at 19, to provide for simultaneous actuation.

In use, the switches 18 will be set to connect the 150 cycle filter in circuit when the phase meter 14 will indicate position, but not so accurately as when the switches are shifted to include the 1,500 cycle filter in circuit, the 1,500 cycle filter failing to give the accuracy of reading on the phase meter that will be possible when the switches are shifted to include the 15,000 cycle filters in circuit.

The 150 cycle filter will indicate in which half of the journey the translational means is located, the additional filters, upon successive use, giving finally the correct position in the area in which the observation is made.

In addition to locating transmitters at the points A and B, additional transmitters may be located at the points C and D and operated on their own independent carrier frequencies. The receivers 10 and 11 may, after an observation taken following their tuning to the transmitters at A and B, be tuned to the transmitters at C and D, thereby determining the position laterally of the line between A and B. Or, the translational means may be equipped with receiving apparatus identical with the receivers 10 and 11 and their attendant parts, so that readings between the stations A and B and the stations C and D may be simultaneously taken, thereby indicating directly on the two phase meters the position in the direction A to B and simultaneously the position with reference to the stations C and D.

Having described the invention, what is claimed as new and useful is:

1. A method for direct indication of position in a given area which comprises projecting from remote points of said area radio waves of any differing fundamental frequencies, impressing on these waves synchronized waves of the same frequencies, so that the synchronized waves will have varying phase relations between said points, and then determining position at any intermediate point by the measured phase relation of the synchronized waves at that point.

2. A method for direct indication of position in a given area which comprises projecting from remote points of said area carrier waves of differing fundamental frequencies, impressing on these waves synchronized modulation waves whose wave length is directly proportional to the distance separating said points, so that there will be a progressively varying phase relation of said modulation waves between said points, and then determining position at any intermediate point by the measured phase relation of the modulation waves at that point.

3. A method for direct indication of position in a given area which comprises projecting from remote points of said area carrier waves of differing fundamental frequencies, impressing on these waves synchronized modulation waves of the same frequencies and whose wave length is directly proportional to the distance separating said points, so that there will be a progressively varying phase relation of said modulation waves between said points, and then determining position at any intermediate point by the measured phase relation of the modulation waves at that point.

4. A method for direct indication of position in a given area which comprises projecting from remote points of said area carrier waves of differing fundamental frequencies, impressing on these waves synchronized modulation waves of the same frequencies and whose wave length is directly proportional to the distance separating said points so that there will be a progressively varying phase relation of said modulation waves between said points, separately receiving the carrier waves at any intermediate point, and then measuring the phase relation of the modulation waves at that point to determine its position with respect to either or both of said remote points.

5. A method for direct indication of position in a given area which comprises projecting from remote points of said area carrier waves of differing fundamental frequencies, impressing on these waves modulation waves whose frequencies are in geometrical progression and directly proportional to the distance between said points, the modulation waves impressed on one carrier wave having the same frequencies as those impressed on the other carrier wave and the modulation waves of like frequencies on the two carrier waves being synchronized, whereby there will be a progressive varying phase relation of the modulation waves, and then determining position at any intermediate point by successively measuring the phase relation of the modulation waves of successive pairs.

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REPLY BRIEF FOR APPELLANT

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA CIRCUIT

United States Court of Appeals
For the
District of Columbia Circuit

FILED JAN - 2 1958

Joseph W. Stewart
CLERK

No. 13,902

DONALD H. JACOBS,

Appellant,

v.

ROBERT C. WATSON, COMMISSIONER OF PATENTS,

Appellee.

APPEAL FROM THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

DONALD H. JACOBS, Pro Se

The Jacobs Instrument Company
Bethesda, Maryland

Robert I. Thiel, Printer
Washington, D. C.
EX 3-0625

STATEMENT OF QUESTIONS PRESENTED

1. Is a suit for a patent under 35 U.S.C. 145 a new case, involving a trial de novo, or is it a review of the decision of the Board of Appeals of the Patent Office? Appellant took the first position, and presented his case with sworn testimony. Appellee took the second position, and presented no testimony, only unsworn assertions of counsel.

2. May the defense, in a suit under 35 U.S.C. 145, introduce alleged new grounds of anticipation of the invention with no advance notice thereof to the plaintiff?

3. Is appellant's invention new in a patentable sense, and do the claims at issue properly define the invention? Were the District Court's findings of fact consistent with the evidence?

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IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

No. 13,902

DONALD H. JACOBS,

Appellant,

v.

ROBERT C. WATSON, COMMISSIONER OF PATENTS,

Appellee

On Appeal from the United States District Court
for the District of Columbia

REPLY BRIEF FOR APPELLANT

INTRODUCTION

This is an appeal from the judgment (At.A.10) of the U. S. District Court for the District of Columbia dismissing appellant's complaint (At.A.1) in an action for a patent under 35 U.S.C. 145. In that action appellant prayed for a patent on a high-precision radio navigational and position finding system (Patent Application No. 60,731, filed 18 Nov. 1948).

APPELLANT'S APPLICATION

Appellant's invention is a radio navigation and position-finding system which is designated JAINCO (for JAcobs INstrument COmpany). It was conceived by appellant in 1948, and shortly thereafter was utilized by him as the basis for an electronic bombing and navigational system which he invented. Appellant constructed JAINCO equipment under a Navy contract.

The entire system was given the designation Bomb Director System Mark 6 by the Navy, and it was given the inter-service designation AN/ARB-1. After the JAINCO equipment had been constructed and tested, the Government stated, in a Motion filed in the U. S. District Court for the District of Maryland on 16 June 1954, that appellant's navigation and bombing system ". . is essential and vital to the national defense of the United States. .".

The JAINCO system (the invention on which a patent is sought) comprises the following:

1. A system of fixed reference stations comprising one master station and a plurality of slave stations. The fixed stations are linked together by radio, and each transmits a continuous radio signal. Each fixed station transmits on a different carrier frequency. A series of modulation frequencies is impressed on the carrier waves of the fixed stations. The modulation frequencies transmitted by the fixed stations are all kept synchronized in phase by the inter-station radio links.

2. A movable station (in the system which was constructed, located in an aircraft) which contains a plurality of radio receivers, one for each fixed (ground) station. Each receiver is left continuously tuned to the fixed carrier frequency of the fixed station whose signal it is receiving.

3. A series of filters for separating the various modulation frequencies from each other in the outputs of the receivers in the movable station.

4. A series of unique cathode-ray tube devices for comparing and indicating the phases of the modulations, in pairs, in such a way as to give two very precise position coordinates. The position coordinates are measured and indicated in such a way that they may be used for navigating purposes.

A unique advantage of the system over the prior art is that it gives very precise position and navigating information continuously and automatically, even when constructed of imprecise components, and hence it may be used for the navigation of high-speed aircraft. It requires no operator, and no adjustments in use, and hence can be used even in fighter aircraft.

Appellee implies that the idea of radio phase comparison is old, and hence there is nothing new in appellant's system. It is true that the idea of phase comparison is old. It has been applied in many ways to distance-measuring and position-finding systems, and various patents have been granted on such systems. The question, then, is not whether phase comparison has been used before, but whether appellant's invention is significantly different from prior systems. Appellant's description of his Fig. 1 in his specification (Ae.A.2a)("Fig. 1 is a diagram used to illustrate the principle of the determination of a distance difference by a phase comparison measurement;") shows appellant claimed nothing unique concerning this principle.

One of the highly unique features of JAINCO is its phase comparing and indicating system which requires no operator, yields extremely high accuracy, and is instantaneous and completely automatic in operation; yet is very compact and of light weight, and is not affected by heat, shock, vibration, and the other difficult environmental conditions experienced in the actual practical use of navigating equipment. No other phase comparator known to appellant has these attributes. This device was completely described in the specification and drawings. Appellee contends that this is not patentable because the appellant has not stated in his specification the advantages of this system over earlier systems. Appellant contends (a) that appellee's assertion is not correct, and (b) that laudatory comments on an invention are not necessary in a specification. A specification, according to 35 U.S.C. 112 (Ae.5) ". . shall contain a written description of the invention, and of the manner and process of using it. ." (Emphasis added). Whether an invention is superior over the prior art, or different from the prior art, is a question to be determined by weighing the relative characteristics of any two devices. Thus in Potts v. Coe, 78 U.S.App.D.C.297; 140 F.2d 470 it was held that

> "In determining whether an invention has been made, the character of the article or process, its novelty, and its advance from the prior art are merely evidentiary, and the ultimate question is the character of the inventor's contribution. . . .".

Appellee also contends that the fact that appellant's invention gives simultaneous, continuous, and automatic phase comparison arises from the fact that this is the way appellant ". . . sees it now, rather than a description of what he disclosed in his application specification and original claims." Appellee's statement is not founded in fact. Appellant described the proposed use for his system in his specification. In connection with his Fig. 8 (which shows the operation of two stations of his Fig. 10, which is the species now being prosecuted), appellant stated in the original specification, at p. 12, "The method by which my invention can be applied to the navigation of an aircraft . . . is illustrated in Fig. 8.", and at p. 13 stated:

> "The above described application of my invention can also be used for flying an aircraft automatically or manually along a path predetermined to bring the aircraft to the proper point for release of a bomb. A second pair of stations similar to J and K of Fig. 8 can be so located on the ground as to cause a given hyperboloid generated by them to intersect, at some desired point, the hyperboloid generated by the first pair of stations, along which the aircraft is flying. When the aircraft reaches the release point, which is the intersection of the two hyperbolas, release of a bomb or some other phenomenon can be accomplished manually or automatically."

The specification also states (Ae.A.1a-2a):

> "Some representative applications of this invention are as follows: * * *
>
> "2. the continuous determination of the position of an aircraft, projectile, vehicle, ship, or other fixed or moving object from a plurality of reference points. For example, the position of an aircraft can be continuously and very accurately determined from a plurality of ground stations. . .".

> "3. The automatic giving of directions to the pilot or other occupant of an aircraft for keeping the aircraft on a predetermined course. Hence it is applicable to aerial navigation, . . .". (Emphasis added).

Appellee's allegation that appellant's contentions about the simultaneous, automatic, and continuous nature of his phase comparisons, and hence of the navigation characteristics of his system, were not realized by appellant at the time the application was filed are seen to be without foundation in fact.

THE PRIOR ART

Appellee asserts (Ae.3-4) that the Holmes patent discloses a phase comparison position-determining system using three fixed stations, each transmitting on a different carrier frequency, and having a single common modulation frequency impressed thereon, with means at a moving station for "separately and simultaneously receiving the modulation frequencies from any pair of the reference stations and simultaneously and automatically to indicate the phase difference for each pair."

Appellant asserts that no such three-station system is shown by Holmes. Holmes discloses a number of different systems. Some of them are obviously inoperative, and no claims were allowed on them. The systems which are operative, and on which claims were allowed, which are covered by Holmes' Figs. 1-3, are not covered by appellee's language, and were not relied upon at the trial. Appellee's language apparently relates to Holmes' Figs. 4 and 5, on which no claim was ever granted, and which hence were clearly found to be unpatentable. Holmes' Figs. 4 and 5 disclose a mobile station having ". . a radio receiver 41a which is capable of receiving the modulated carrier waves for either pair of stations. .".

The language used both by Holmes and by appellee call for the single receiver to receive the transmissions from the two different transmitters of any pair of reference stations simultaneously. This can be done if the transmitters transmitted on the same carrier frequency. But in that event the common modulation frequency removed from the two carriers in the single receiver would appear in the output of the receiver with a single phase angle, and no phase comparison could be made, and nothing could be learned from the measurement. Thus Holmes and appellee distinguish clearly from appellant's system, even if one neglects appellant's many other distinguishing features, such as one receiver at the moving station for each fixed station, and the use of multiple modulation frequencies, and the use of appellant's unique phase comparing and indicating system. Holmes' Figs. 4 and 5 would only yield an operative system if a plurality of receivers were in the moving station and this possibility is excluded by Holmes. The fact that Holmes' single receiver 41 in his moving station cannot receive more than one ground station (if the ground stations transmit on different frequencies, as is necessary for applicant's system) at a time was acknowledged by appellee's counsel at the trial, as follows (Tr. 47-8):

> "MR. ROEMING: * * * Now, it is well known in the art that when you separately receive carrier waves of different frequencies, you have to have separate receivers."

So, if Holmes' Fig. 4 is to be used as a reference, it is necessary to demonstrate that the equipment which Holmes describes (Ae.A.61a, Col. 2, L. 71-2) as "a radio receiver" really comprises a plurality of receivers. The Patent Office brought in the Shanklin reference to try to prove (Ae.A.26a, last par.) that "a radio receiver" really means a plurality of receivers. The language they used (Ae.A.27a) was, "Thus, while Holmes may not show a plurality of receivers, it is well known that his "receiving equipment 41" will include a plurality of receivers as shown by Shanklin". This logic is clearly defective.

Appellee alleges (Ae.4) that Holmes discloses that the unknown (moving) station has apparatus ". . simultaneously and automatically to indicate the phase difference for each pair." This was new matter, injected into the trial without warning.

Thus at the trial appellee asserted (Tr.48): "I further note that at page 6, Column 1, line 36, the inventor Holmes refers to "automatically and continuously" receiving indications". The Court thereupon inquired, "Well, does he show automatic means?", and appellee replied, "The position we take is this: That phase comparators were old at the time and automatic means are merely achieved by multiplying these comparators." The Holmes device shows a highly distorted "map", on which a spot of light is projected to indicate the position of an aircraft (the device is inoperative, incidentally, when vibration -- such as occurs in an aircraft, or any other moving body -- is present to cause the delicately-balanced mirror which reflects the light beam to swing back and forth). A plurality of such indicators would involve a series of distorted maps, each to a different scale (for example, one covering the United States, one covering a state, one a county, one a township, etc.). Thus, in a system using, for example a 10:1 ratio of modulation frequencies, the user would first determine his position by noting the position of the spot of light on the map obtained with the lowest modulation frequency. This would tell him which one of ten maps he should select and place on the next indicator. This in turn would tell him which one of 100 maps to place on the next indicator. He would then similarly select 1 of 1,000 maps for the next indicator, and 1 of 10,000 for the next, in a typical system using five modulation frequencies. Such a system, which obviously could be used only with a motionless "mobile" station, does not permit automatic, or simultaneous, or continuous determination of position. If appellee knows of any better method to propose for using the Holmes phase comparator in a multiple-modulation-frequency system, he has failed to suggest it. The various map-selecting and adjusting operations in Holmes' system must of necessity be performed successively and manually; they cannot be performed simultaneously and automatically.

Appellee asserts "The patent to Strobel discloses . . the apparatus for . . continuous and simultaneous phase comparison. . .". Appellant asserts that this statement is clearly incorrect. Strobel utilized a series of modulation frequencies for increasing the precision of measurement in a distance-measuring system (not a navigational system), but he showed no means whatever for continuous and simultaneous phase comparison, other than suggesting that "simultaneous" phase comparisons could be made by using a plurality of his manual systems. Each of these systems requires a painfully long series of manual manipulations and decisions to yield a measurement.

As appellee admits (Ae.4), Shanklin utilizes means ". . for successively comparing the phase . . .". (emphasis added). Other features of Shanklin which readily distinguish his invention from appellant's are his lack of description of his phase comparing means, his switches for shifting from one modulation frequency to another, and his non-use of radio synchronization between his fixed stations to keep the modulation frequencies synchronized.

SUMMARY OF ARGUMENT

1. Holmes neither described nor was granted any claims on any single-modulation-frequency system of radio navigation which resembles applicant's. Strobel describes the use of a plurality of modulation frequencies for increasing the accuracy of distance measurement (not navigation), and he describes only a slow manual system whereby each phase comparison may be made, in turn, by a series of lengthy manual adjustments and decisions. The addition of Strobel's multiple modulation frequencies to the Holmes device does not give a navigation system resembling applicant's. Strobel's painfully slow system of successively and manually measuring phase does not produce results which even remotely approximate the results obtained with appellant's automatic and simultaneous phase comparators.

2. The system of Shanklin involves several modulation frequencies, but lacks simultaneous phase comparison, and lacks any phase comparison means (other than a box, of undisclosed contents, labelled "phase meter"), and no radio synchronization between the fixed stations. The addition to this system of Strobel's manual system of adjustments for each successive phase comparison yields a system which is a far cry in structure and in effectiveness from appellant's. The use of Holmes' phase comparator (Figs. 8 and 9) yields a system far slower, and requiring more manual manipulation, than Strobel's.

ARGUMENT

HISTORY OF APPELLANT'S APPLICATION

Appellee professes to see some sinister significance (Ae.7) in the fact that appellant has fewer claims before this Court than have been in the application at various times. Appellee has not given any reason, however, for the Patent Office having agreed to allow a number of claims if the appellant would withdraw certain claims, and then violating its pledge when the appellant had carried out his part of the bargain. If appellee sees something sinister in this, appellant will not dispute him.

Appellee asserts (Ae.7) that appellee declined to ". . take advantage of his right to further prosecution under Patent Office Rule 196(b) . . .". This statement is completely without foundation in fact. Appellant received an adverse decision from the Patent Office's Board of Appeals dated 30 Nov. 1954. At this time four possible courses of action were open to appellant, as follows: (1) A request for a trial de novo on the merits in the District Court under 35 U.S.C. 145, (2) An appeal to the Court of Customs and Patent Appeals under 35 U.S.C. 141, (3) Return of the case to the primary examiner on only two of the claims, or (4) A request for reconsideration to the Board of Appeals. The appellant elected to exhaust his administrative remedies via the last-named procedure. Accordingly he filed a petition for reconsideration with the Board of Appeals. This was rejected by the Board of Appeals on 25 April 1955. At that time, under Rule 196(b) he had only two alternative courses of action: A trial de novo under 35 U.S.C. 145 or an appeal to the Court of Customs and Patent Appeals under 35 U.S.C. 141. He was permitted no further action in the Patent Office. He elected the first of these alternatives, having completely exhausted all possible administrative remedies.

Appellee objects to the fact that appellant did not utilize counsel before the District Court. There was good and sufficient reason for such action. Such reason is a matter of public record, and is set forth in detail in appellant's petition for certiorari filed in the Supreme Court of the United States, in Case No. 752, October Term, 1956.

Appellee implies (Ae.7) that inconsistency exists between appellant's statement (At.3) that he tried to get into evidence the testimony of two other professional scientists, and the portion of the record quoted by appellee at Ae.A.48a. Appellant not only asserts that there is no inconsistency between the two, but further asserts that appellee's counsel knows first-hand that appellant's contention is correct, for appellee's counsel spoke to the two scientists in question, and to appellant, concerning the fact that they were in court to testify, and he saw appellant try to get their testimony into evidence. That proffered technical testimony should be received in evidence is beyond dispute (International Standard Electrical Corp. v. Kingsland, 169 F.2d 890, 83 U.S. App. D.C. 355).

Appellee challenges as inaccurate (Ae.7) appellant's statement that the "Court refused to read the plaintiff's memorandum." Appellee's challenge is made with a full knowledge that it is untrue, for on 6 March 1957 appellant presented his Memorandum (which demonstrated that appellee's proposed Findings of Fact and Conclusions of Law were inconsistent with the evidence) to the Court in the presence of appellee's counsel. This memorandum consisted of six typewritten pages. The following colloquy took place (Transcript of 6 March 1957, pp. 2-3):

> "MR. JACOBS: I would like to present this memorandum on the proposed findings of fact.
>
> THE COURT: You may submit it. Of course, your memorandum does not relate to the formal findings, you are really re-arguing the merits of the case; but that is past.
>
> MR. JACOBS: Your Honor, the position of the Patent Office has changed since the arguing of the case in their proposed findings of fact . . . .
>
> * * * * * * * * * * * * *
>
> THE COURT: I am signing the findings as modified."

The entire colloquy did not take more than some three minutes, and the Court did not read beyond the title of appellant's six-page memorandum.

Appellee states (Ae.8) that appellant should have appealed to this Court from the denial of his motion for a new trial. Appellant is not qualified to argue this point with authority; he can only state that it is his understanding that under 28 U.S.C. 1291 this Court has jurisdiction over appeals from all "final decisions" of the district court, and that a ruling on a motion is not generally considered to be a final decision unless the motion is the only issue being contested. He does believe, however, that a hearing should have been held on this motion, and the issues presented therein properly heard and determined. It seems impossible to appeal when there has been no hearing, and hence no Record.

APPELLANT'S STATEMENTS OF QUESTIONS PRESENTED

Appellee asserts (Ae.8) that appellant has a misconception of "the nature of a civil action under 35 U.S.C. 145". Appellant's position, as stated before (At.1) is that such a suit is a trial de novo; not an appeal from the Board of Appeals. That appellant's position is correct is evident not only from the specific wording of 35 U.S.C. 145 (At.A.12), but also when viewed in the light of judicial authority:

> The bill in equity provided by this section is wholly different from the proceeding by appeal from the decision of the Commissioner, the one being in the exercise of the original, the other of appellate jurisdiction. In re Hien, 166 U.S. 432.
>
> The proceeding under this section is a proceeding de novo in equity, . . . it is not a technical "appeal" from the Patent Office. . . American Steel and Wire Co. of N. J. v. Coe, 105 F.2d 17.
>
> . . . court had duty of trying facts de novo. Bruegger v. Marzall, 112 F. Supp. 20.
>
> The equity suit against the Commissioner of Patents under this section is a trial de novo . . . . General Electric Co. v. Hygrade Sylvania Corp., 61 F. Supp. 476.
>
> An action against the Commissioner of Patents under this section is a suit de novo. Minnesota Mining and Mfg. Co. v. Coe, 49 F. Supp. 706 and other cases.
>
> A proceeding to require issuance of patent is not a technical "appeal" from the Patent Office but a "proceeding de novo". New Wrinkle v. Coe, 31 F. Supp. 415.

The appellant made clear his position that he believed the trial of this action to be a trial de novo at the very beginning of the trial in the district court, so as to put the appellee fairly on notice as to what quality of defense he would be expected to present. Thus the following appears in the trial transcript at pp. 2-3:

> MR. JACOBS: This is an action for obtaining a patent under 38 (misprint) U.S.C. 145. With reference to the legal phase of the case, it is my understanding that upon denial of a patent application by the Appeal Board of the Patent Office that the applicant can either appeal- -.
>
> THE COURT: Well, now, the Court is familiar with these elements. Suppose you get right to the case.
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> MR. JACOBS: Well, there is one point here which appears to be in contest, and that is whether this is basically a review of an Appeal Board action or a suit for a patent. It is our position that it is basically a suit for a patent.
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> THE COURT: Well, that is the only kind of suits that this Court will entertain. Now, why don't you go ahead with your case?
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> MR. JACOBS: Very well, your Honor.

There appears to be little doubt on the part of any party that a suit under 35 U.S.C. 145 involves a trial de novo. Now, what weight should be given to the evidence? To some extent this question is moot, for the appellant presented his case in the form of sworn testimony, and was subjected to cross examination; the appellee relied solely on unsworn assertions of counsel. Thus, from a legal point of view, the appellee presented no case.

What is the burden of proof in a trial de novo? Are both parties to be considered equal in the eyes of the Court, or are the scales of justice to be weighted deliberately in favor of one party? The appellee asserts (Ae.9) that the appellant ". . has the burden not merely of convincing this Court on a preponderance of evidence. . .; he has the far heavier burden of proving that there was no rational basis in the evidence before the District Court for its decision when it either agreed with the Patent Office tribunals or found no clear error in their holdings." Appellee clearly believes that the trial in the District Court was a mere review of the Patent Office decision. He also believes that the scales of justice should be clearly weighted in favor of the Patent Office in the District Court. He asserts (Ae.9) "At the trial . . . appellant had the burden of going forward . . to prove clear error by the Patent Office tribunals or . . to overcome the presumption of correctness."

There can be little doubt as to why appellee feels called upon to urge that the scales be weighted in his favor. Some comments as to the implications of this position appear pertinent:

1. The presumption that the Patent Office is correct changes the question of patentability from judging a question of fact (is the applicant's invention different from the prior art and do the claims properly define it?) to one of opinion (Is applicant's invention superior to the prior art?). Thus, in the many years the present application was before the Patent Office, the discussions dealt primarily with questions of fact. However, on the last page of the last Office action, when appellant only

could proceed further in court, the Patent Office put in two new objections (Ae.A.45a): an allegation that there is no evidence proving that appellant's system is superior (to what?), and an allegation that the Patent Office never had understood the disclosure. On the question of superiority, one could argue forever. Thus a patent on the first automobile could have been rejected on the basis that an automobile is not superior to a horse (a horse needs no gasoline, can go over broken terrain, etc.). Such debates are infantile and meaningless. Hence, although appellant's invention gives automatic indication of position and the prior art could not, how can one overcome a "presumption" that an automatic system is not superior to a manual one? The allegation of the Office that it could not understand the invention is equally meaningless: the application had been prosecuted from 1948 to 1955, and this had involved voluminous correspondence and a number of conversations. In all this time the Patent Office had shown a completely perceptive grasp of the invention, and had made no objection on the grounds of insufficient disclosure; yet when the case was obviously headed for Court the Patent office developed a very sudden obtuseness, and this occurred at a time when the appellant was foreclosed from replying to the allegation. To place the burden of proof in Court on the applicant on such questions as these (and if one removes clear-cut questions of fact from the case, all that is left are these vague and frivolous questions) is to destroy the value of 35 U.S.C. 145.

2. Of great basic importance is the inevitable implication to be drawn from the philosophy appellee urges upon the Court. Specifically, appellee urges that the district court divest itself of its judicial power. This conclusion arises inevitably from appellee's urging that the district court act as an agency to review (by an appeal process) the findings of the Patent Office. Such a function (review of Patent Office Appeal Board decisions) has been found to be the function of a legislative

court in Butterworth v. United States ex rel. Hoe, 112 U.S. 50. The fact that a legislative court is, by definition, a court which is established by legislation and which is not vested with the judicial power of the United States, was first set forth by Chief Justice Marshall in 1828 in American Insurance Company v. Canter, 1 Pet. 511. For a long period of time (up to 1933), the Supreme Court viewed the D.C. courts as legislative courts without judicial power. Adoption of appellee's position that their function is merely to review Patent Office decisions has the effect of urging the D.C. courts to divest themselves of judicial power relative to patent matters.

3. Any presumption in favor of any party to a judicial proceeding is violative of due process.

4. The U. S. Constitution recognizes the possibility that an executive agency can make decisions which are bad and wrong. For this reason the doctrine of Separation of Powers was established therein, and 35 U.S.C. 145 was established in accordance with that doctrine. An assertion that a trial under this Act is a review of a Patent Office decision, and that a plaintiff thereunder must overcome a burden of correctness of the decision of the Patent Office appears to violate the doctrine of Separation of Powers, for (to an appreciable extent), it forecloses the courts from determining de novo whether the Patent Office has acted correctly.

Appellant raised the question in his brief (At.1) whether ". . the defense . . may introduce new grounds . . . with no advance notice to the plaintiff." (Emphasis added). Appellee has not responded to this question, but argues at length (Ae.10) that the defense can utilize new grounds. Appellant agrees he can do so (At.7,L.3) with proper notice. Appellant again inquires whether the defense can introduce new grounds without advance notice. None of appellee's citations deals with this issue. Appellee contends (Ae.11) that appellant should have been familiar with each of the reference patents in their entirety. Appellant contends that he should have been familiar with all parts of those patents which were relied upon by the Patent Office in any and all of its decisions; not with parts to which no reference was ever made by the Patent Office and which dealt with devices completely different from those cited by the Patent Office. Appellee inserted new matter by referring to a column and line in a patent; he never disclosed the nature of the new reference he was thus furtively bringing before the trial court. Does appellee contend that appellant should have been familiar with the number and contents of each line in each reference patent?

APPELLANT'S TESTIMONY

Appellee contends (Ae.11) that appellant's testimony at the trial ". . . was primarily devoted to explanation of appellant's specification disclosure and to arguments as to the reference patents. Appellant's testimony adduced no facts indicating error in the decisions of the Patent Office tribunals." It is appellant's position that even though he was prevented from putting in the testimony of two other expert witnesses, the testimony (which was uncontroverted by a single word of sworn testimony by appellee) established clear, easily understandable, basic, and vital differences between his invention and any of the reference inventions or any combination of reference inventions. Hence he takes the position that the findings of fact are inconsistent with the evidence, and that the judgment of the district court should be reversed. Thus, this Court has held, in Abbott et al v. Coe, 71 U.S.App.D.C.195, 109 F.2d 449: "In action to obtain a patent after rejection of application by patent office, the question for the court is not whether in court's opinion there was invention but whether the finding that there was none is consistent with the evidence."

Appellee contends that appellant should have printed this evidence in his brief. Appellant would have been pleased to do so. However questions of cost militated against this, and a description of the invention has been given both in appellant's brief (At.7-12) and in appellee's (Ae.A.1a-19a). Various other portions of the testimony have been used in appellant's briefs. The contents of appellant's appendix has nothing to do with the question of whether the trial court should have ruled in favor of a party who did not put in a single word of testimony.

THE CLAIMS AT BAR

Appellee asserts (Ae.12) that "An analysis of appellant's claims is found in Finding of Fact No. 3." This Finding of Fact does not purport to give a complete analysis of the claims, as is clear from the language used therein. This Finding states, in part, "Claims 60 through 64 differ from claims 33 and 37 at least as follows . . .". (Emphasis added). A Finding which gives a partial analysis cannot properly be termed "an analysis".

Appellee argues (Ae.12) that various of appellant's claims which utilize phrases such as "separate means . . . for comparing the phase of the modulations . . and automatically indicating said difference in phase" could be interpreted as encompassing automatic successive indication. This argument of appellee's clearly shows his own realization that none of his references (Holmes, Strobel, Shanklin) show means for continuous automatic indication of the phase differences, as is absolutely necessary for a continuous indication of the position of the moving station. As far as the semantics of the situation is concerned, automatic indication of phase and automatic successive indication of phase are distinctly different phenomena.

Appellee argues (Ae.13) that claims 62 and 64 are more effective than the other claims. He argues further that claims 60, 61, and 63 use rather broad terminology in describing the phase comparing and indicating means. He does not mention that these latter claims distinguish over Holmes Figs. 4 and 5 in specifying receivers at the moving station for each fixed station, and in specifying a plurality of modulation frequencies, and in specifying that each fixed station must utilize a different transmitting frequency, and in specifying that each fixed "slave" station must have means for receiving the modulated transmission from the fixed "master" station. They distinguish over the disclosure of Holmes' Fig. 6, and of the foregoing inventions of Holmes plus his phase comparator of his Figs. 8 and 9 in all the foregoing ways plus additional ones. These claims distinguish over Shanklin's invention by specifying radio links for synchronizing the fixed "slave" stations to the fixed "master" station, that is, receivers at the "slave" stations which are tuned to the "master" station transmitter and demodulating means at the "slave" stations. Then, too, these claims specify phase comparing means, and in accordance with 35 U.S.C. 112, 3rd par. (Ae.5) this part of the claims is to be read as referring to the novel means disclosed in the specification.

The above remarks apply to claims 30 and 37 also. In addition these claims distinguish over the references by specifying devices for "automatically comparing the phases of the modulations", and hence are even further distinguished over the references.

Appellant has claimed that the third paragraph of 35 U.S.C. 112 means what it says. Appellee contests this (Ae.13), arguing that appellant's contentions are not compatible with the second paragraph of the same statute. Appellant replies that he sees no inconsistency whatever between the second and third paragraphs of the statute. It seems clear to appellant that the specification must contain a detailed description of the invention. It seems equally clear that such a detailed description cannot be repeated in a claim; otherwise the claim would be a mere repetition of the specification.

The nub of the appellant's contentions as to the reasonableness of the instant claims is that they do define an invention which is new and has proven very useful, and they do not read on the prior art.

FINDING OF FACT NO. 4

This finding relates to the Holmes patent (Ae.A.49a-65a). During the trial, appellee relied on Holmes' Figs. 4-6 (Tr.23, 46, At.22).

In his brief, appellee again argues (Ae.14-15) that Holmes' disclosure that his mobile station 41 contains a single radio receiver (Ae.A.61a, Col. 2,L.71-2) really means that Holmes meant a plurality of receivers. The contention that one radio receiver is a plurality of radio receivers had been made repeatedly by appellee. Appellee now follows the line of argument that if Holmes had wanted to invent a system resembling applicant's, he would have used (among a wide variety of other changes) a plurality of receivers in his mobile station. The fact that Holmes didn't invent or describe such a system is apparently considered irrelevant by appellee, and the fact that Holmes did specifically state that he used a single receiver on his mobile station is apparently also considered by appellee to be irrelevant. It may be added that the Patent Office did not, at the time Holmes applied for a patent, have a sufficiently high opinion of the device shown in his Fig. 4 (or 5 or 6) to grant a patent on it. It was perhaps unfortunate for Holmes that at that time the Patent Office did not advance its current theory that what Holmes had in mind was not what he showed in his figures and described in his specification, but a quite different and operative system that was to be invented in the future. After viewing the appellant's patent application and then using 20/20 hindsight, the Patent Office can now see things in the Holmes' specification which neither Holmes nor the Patent Office could see when he was denied claims on his Fig. 4 (and 5 and 6). As a matter of fact, Holmes reveals (Ae.A.62a, Col. 1,L.46-50) that he proposes that "the phase difference of the modulation frequency of any one pair of stations . . . may be compared with the phase difference of the modulations received from the other pair of stations". This concept is vastly different in its basic philosophy than is appellant's. Appellant confesses he doesn't even understand what Holmes learns from this comparison, and he suspects that appellee doesn't either.

Holmes Fig. 6 discloses a system of hyperbolas, with three points to represent fixed reference stations. What equipment is to be used at the fixed stations, or at the mobile station (which is not shown)? Holmes suggests that the apparatus of his Figs. 1-5 is useable. The mobile station of his Fig. 1 has one receiver; that of his Fig. 2 has two receivers; that of his Fig. 3 has one receiver; that of his Fig. 4 has one receiver; and that of his Fig. 5 has one receiver. Appellee contends (Ae.16) that Holmes suggests the use of different carrier frequencies for the three fixed stations of Fig. 6. Granting this, how is he going to get enough receivers from Figs. 1-5 to receive these three transmissions at his mobile station? At least three are required, and a maximum of two receivers are specified by Holmes in his Figs. 1-5, and no more than two are specified in his claims. Appellee apparently contends that Holmes would have invented appellant's system, if he had gotten around to it, and hence is a valid reference.

At the time Holmes applied for a patent, the Patent Office saw nothing of value in his Figs. 4-6 and allowed no claims on them; now, with the teachings of appellant before it, the Patent Office thinks Holmes could have invented something useful in those figures if he had only used different equipment, and used it in a different way. Appellant submits that a reference selected in such a way does not have merit. It may be noted that appellee's voluminous arguments concerning Holmes (Ae.14-19) are concerned basically with explaining that the Court should not heed what Holmes discloses, but should instead accept a long chain of rationalization as to what Holmes should have disclosed (but didn't).

Appellant (and later appellee) have pointed out that Holmes suggested the possibility of using a cathode-ray tube type of phase indicator. The type suggested by Holmes is well known to the art, and involves coupling one opposing pair of oscilloscope plates to one frequency source, and the other pair of plates to the other source. The difficulty with this type of phase indicator is that an ellipse is presented on the face of the tube, and the phase difference is indicated by the shape of the ellipse. It is impossible to judge such a thing by eye with any accuracy at all, so such an indicator is used only with equipment which can be used to make measurements on the shape of the ellipse. From such measurements, and some mathematical computations, the phase difference can be determined.

Appellant's phase comparator involves a quite different theory, and quite different construction (the incoming signals of one modulation frequency are connected, via an electrical network, to adjacent plates), than the above device. Appellant's comparator shows a straight line across the face of a cathode ray tube. This line rotates about a point at the center of that face. Hence it acts like, and is read like, a rotating pointer. Phase differences are marked about the circumference of the tube. A series of these indicators may be used, side by side. A position coordinate, of an aircraft for example, may be read from these tubes with a single glance of the eye to five- or six-digit accuracy. The device Holmes suggests would merely reveal a series of ellipses to the eye of an observer -- he could extract no useful information from these ellipses without a large number of measurements and computations and the use of a trigonometric table. It could not give continuous and automatic indication of phase in the sense that appellant's does.

Appellee points out that appellant stated that he could not find any commercially available phase angle indicator, and incorrectly infers from this statement that other satisfactory types were available. This is not so. It is true that phase comparators had been known to the art, but none met the requirement that they be easily read by eye, automatic, instantaneous in response, light and compact, capable of being used to indicate a sequence of digits in a number, capable of operating satisfactorily in a moving vehicle (i. e., insensitive to shock, vibration, temperature extremes, etc.), and so forth. The only one known to appellant that met these requirements was the one he set forth in his application.

There is a big difference between a phase comparator which can be operated only in a laboratory, and one which can be used in a moving vehicle. There is also a big difference between a manual phase comparator and an automatic one.

With reference to the phase comparator described in Holmes' Figs. 8 and 9 (the new invention brought in without warning during the trial by appellee), it is pointed out that it involves the use of a delicately balanced mirror which deflects a beam of light onto a map. It obviously cannot be used in a moving vehicle, where shock and vibration would cause the mirror to swing uncontrollably. Then, too, because it is incapable of producing hyperbolas (in contrast to the implication of Holmes' Fig. 8, the map it produces for a single modulation frequency (as utilized by Holmes) would be vastly distorted and not usable for navigation, for a straight line on the ground is not represented by a straight line on the "map", and hence one cannot navigate from one point to another by drawing a line on the map joining the points. The fact that the Holmes device gives a very distorted "map" was clearly realized by Holmes (Ae.A.63a, Col. 2,L.40-47), who argues that "it is not necessary for the light spot 60 to trace actual hyperbolic curves", and who further states that the phase comparator may be provided with a "distorted map".

The Holmes phase comparator breaks down completely when an attempt is made to apply it to applicant's system which uses multiple modulation frequencies. Thus, for the lowest modulation frequency, a beam of light indicates the position of the reference station on a distorted map. When the next modulation frequency is considered (and, for a practical example, the modulation frequencies will be related in a 10:1 ratio), there are ten possible maps which may be involved. The operator of the equipment must determine from the first map, at any instant in time, which of ten possible distorted maps to insert in the second phase comparator. After he has done this, he may now determine which of 100 possible distorted maps to insert in the third phase comparator, and then which of 1,000 distorted maps to insert in the fourth comparator, and then which of 10,000 maps to insert in the fifth. After he has done all this he can still only try to establish his position on a vastly distorted map. Every time he wishes to establish his position he has to repeat this map selection process. This can, by no conceivable stretch of the imagination, be said to give continuous or automatic or simultaneous determination of position, or even a determination of position. This is true even in the case Holmes described, with his single modulation frequency. If the unknown station is located at the intersection of two non-hyperbolic lines printed on the map, and this intersection coincides with a known geographical feature, shown on the map, such as a city, the system would, in that particular case, indicate that the moving station was at the city. But if the moving station were in some random location on the map, one could not determine its position, because the fact that a very distorted map must be used means that the eye of the user cannot interpolate between known positions on the map. Presumably random positions could be determined by making measurements on the "map", and reducing these mathematically to compensate for map distortion. But this could not be called continuous or automatic determination of position.

Appellee argues (Ae.19) that the fact that Holmes was granted claims on his comparator carries with it the presumption that it was operative. Even if this were granted, it could only be considered true in the very limited sense indicated above. Also, it cannot be alleged that the Patent Office had foreknowledge of applicant's use of multiple modulation frequencies, and hence the Holmes comparator cannot be alleged to be presumed operative in such a system. The facts themselves have to be reviewed.

Finding of Fact No. 4 relates to a navigation system involving "three reference stations", and states that "the unknown station is disclosed as including apparatus . . . simultaneously and automatically to indicate the phase difference _for each pair_". (Emphasis added). It is pointed out that the Holmes phase comparator (assuming, _arguendo_, that it is operative) that all it can possibly disclose is two phase comparisons (one by each of the two gimbal systems showed in Holmes' Fig. 8). It is obvious that _three_ reference stations (which we can call 1, 2, 3) can be combined in three pairs (1-2, 1-3, 2-3), and hence the Holmes phase comparator cannot possibly meet the language of the Finding in indicating the phase difference "for each pair". Furthermore, it cannot meet the language of the finding in that it cannot be used for "navigating" because straight lines on the ground are not represented by straight lines on Holmes' distorted map. Therefore it cannot be used to determine the position of one geographical point relative to another, in the sense used in navigating.

Finding of Fact No. 4 is also in error in various other ways. It refers to phase comparison of modulation frequencies. Actually, Holmes disclosed no system involving phase comparison at more than one modulation frequency. The last sentence of the Finding is in error because Holmes does not disclose apparatus "simultaneously and separately to receive the modulation frequencies from any pair of the reference station". Holmes does not disclose apparatus for receiving the carriers from the reference stations simultaneously; he proposes the use of _a single receiver_ which is switched to various ground stations in turn. And the reference to receiving "the modulation frequencies" is incorrect for, as stated in the first sentence of the finding, there is only a single modulation frequency.

FINDING OF FACT NO. 5

This Finding relates to the Strobel patent, which reveals the use of a plurality of modulation frequencies to increase accuracy in a distance-measuring system. It does not disclose the use of a plurality of modulation frequencies in a navigation system, nor does it disclose means for making the phase comparisons continuously or simultaneously or automatically. Appellee quotes (Ae.20) an excerpt from Strobel in which Strobel states "For continuous indications which may be interpreted with the greatest rapidity it may be desirable to make the low frequency reading and the high frequency reading simultaneously". There is no question that simultaneous reading of the various frequencies is desirable, but it seems clear that an affirmation of this rather obvious fact by Strobel (or anyone else) is not a disclosure of a means for so doing.

Strobel's basic phase comparison device is shown in his Fig. 2, and the laborious series of manipulations and adjustments which are made for each determination of phase, at each modulation frequency, is described in Ae.A.74a, col. 2, line 59 to p. 75a, col. 1, line 69. Strobel's Fig. 3, on which appellee places great reliance, is described by Strobel (Ae.A.75a, col. 2, L. 3) as "a slight alteration" of his Figure 2. Strobel points out that in his Fig. 3 phase comparator the modulation frequencies must be adjusted to equal signal strength, for each measurement of phase. These signals, which traverse vastly different paths in space, will fluctuate continuously in strength relative to one another, and hence their amplitudes must (as Strobel admits) be made equal before each comparison at each frequency. This, actually, is very difficult to achieve, and Strobel reveals no way of accomplishing it other than showing some manual adjustments. He merely admits (Ae.A.75a, col. 2, L. 4) it must be done. He also discloses additional steps, such as using a reversing switch (At.A.29a, col. 2, L. 29), and shifting the modulation frequency (At.A.29a, col. 2, L. 41) in making each measurement at each frequency.

Appellee argues (Ae.20) that the signal strengths have to be adjusted to equality only once. This is physically incorrect, but even if it were true, there would still be all the other adjustments required by Strobel. Strobel points out that his phase comparison system provides an ambiguous determination of position (Ae.A.75a, col. 2, L. 37-49), and that the ambiguity is resolved by manually shifting the modulation frequency and then noting whether a meter needle shifts one way or the other. Appellee argues (At.21), that the user of the system can refuse to make this determination (and thus refuse to find out the distance he is measuring). Appellee argues that this eliminates one of Strobel's manual adjustments (which must be made for each reading, at each modulation frequency) and thus makes the system more automatic. Presumably one could make none of the adjustments at all, and then the system could be described as adjustment-free. The fact that under such circumstances it would provide no information at all is apparently irrelevant in appellee's eyes. Appellee argues further (and very incorrectly) that none of the various procedures and adjustments described by Strobel need be used at all, and therefore he contends that the "continuous and simultaneous phase comparisons" set forth in this Finding of Fact can be made. Here, again, appellee sees something in an invention which the inventor never saw in it or claimed for it, and which in fact was not in the invention. The adjustments and determinations set forth by Strobel do, in fact, have to be made for each determination of phase, at each frequency, and hence the system does not provide for "continuous and simultaneous phase comparisons" and the Finding of Fact is therefore in error.

In addition to arguing that the adjustments don't have to be made, appellee also argues (At.21) that the adjustments compensate for phase shifts in the apparatus, and hence only have to be made once. This statement is completely incorrect, as is clear from Strobel's specific statements as to the reasons for the adjustments, given at Ae.A.75a, col. 2, L. 3-68.

Appellee also argues that Strobel's lengthy series of adjustments may be an alternative to the use of multiple modulation frequencies. The suggestion is clearly without foundation in fact, for Strobel's wording and illustrations are quite clear. Appellee's suggestion that Strobel had some alternative method of phase comparison in mind, which he did not describe, would appear to have no relevance to the case at bar, even if there were any foundation for such a belief. If appellee's assertion were correct it would render the Finding of Fact more incorrect than now appears to be the case, for it would remove therefrom any allusion to "different modulation frequencies" as well as the reference to "continuous and simultaneous phase comparison". This follows because appellee's allegation that Strobel's phase comparison technique is not applicable to multiple modulation frequencies would mean that Strobel had disclosed no means for making measurements on a series of modulation frequencies. Actually, Strobel disclosed in his Figure 6 that he proposed to use a plurality of the devices of Fig. 3 for use with a plurality of modulation frequencies. The phase comparison systems shown in Fig. 6 differ from that shown in Fig. 3 only in that two additional components (two adjustable capacitors) are shown in the equipment used at each modulation frequency. The function of these capacitors, and the method or criterion by which they must be adjusted to make the system operative, are not described by Strobel. Strobel's Fig. 6 shows that to make a phase comparison at one modulation frequency, the user must adjust two variable capacitors, adjust two variable resistors, watch three meters, and manipulate a reversing switch. Fig. 6 shows that for a phase comparison at three modulation frequencies, six variable capacitors and six variable resistors must be adjusted, nine meters must be watched, and three reversing switches must be operated and their effects on various variables noted. These operations must be performed in the proper sequence each time a measurement is made. To call such a device a system for "continuous and simultaneous phase comparison" is error.

Appellee argues that, because Strobel stated that it is desirable to make low and high frequency measurements simultaneously, it must be presumed that his patent discloses apparatus for continuous and simultaneous phase comparison. There is no basis for appellee's contention. At the most, he could argue that the apparatus disclosed by Strobel might be presumed to be operative. Inasmuch as Strobel never discloses the function of the variable capacitors shown in his Fig. 6 (the only apparatus dealing with phase measurements on a plurality of modulation frequencies), nor tells how to manipulate these capacitors, it is clear that he has never disclosed how to make phase measurements (even manually, and in sequence) on a plurality of such frequencies. All he has really done is indicate that a plurality of frequencies could be used in a distance-measuring system, and he has shown a phase comparison device which allegedly can make a phase comparison at a single modulation frequency via a complex series of manipulations and adjustments.

Holmes statement that "the literature is replete with indicating phase angle meters" has no legal significance, and is binding in no way on appellant. If appellee felt that equipment which anticipated the appellant's invention was disclosed somewhere, it was incumbent upon him to cite it at some time during the many years the case was before the Patent Office.

Appellant admits that various methods of making phase comparisons are known. He does not admit that the device set forth in his specification is the same as the prior art, and his claims have distinguished over the prior art. The best example of the prior art that the appellee could find while the case was in the Patent Office was Strobel's device, and the best device he could furtively insert, without notice, during the trial was Holmes' Fig. 8. These are the specific parts of the prior art which appellee has elected, surreptitiously or not, to utilize in the presentation of his case.

FINDING OF FACT NO. 6

This Finding alleges that none of the claims are limited to "individual phase difference indicators having either a degree of accuracy or a degree of automatism distinguishable from Strobel's indicators used without manipulation of the reversing switches or distinguishable from Holmes' described automatic indicator".

Appellee alleges (Ae.23) that appellant's argument is irrelevant because the phase comparator of Strobel's Fig. 2 is "a device separate and different" from the comparator shown in Strobel's Fig. 3. Strobel states (Ae.A.75a, col. 2, L. 1-3) that his phase comparator of Fig. 3 is obtained by a "slight alteration" in the apparatus of Fig. 2. Appellee argues that Strobel does not disclose apparatus in which the phase shifter, and the resistors are adjusted at different times. Strobel states that all these elements must be adjusted, and his description makes clear that the adjustments must be made in a logical sequence -- the adjustments cannot be made simultaneously, for logical reasons, even if the operator had three hands and heads. Appellee apparently finds difficulty in agreeing with his own reference.

Appellee argues (Ae.23) that the use of Strobel's phase comparators is not required to meet appellant's claims. As Strobel was the only reference that was cited against the portions of parisons are known. He does not admit that the device set forth in his specification is the same as the prior art, and his claims have distinguished over the prior art. The best example of the prior art that the appellee could find while the case was in the Patent Office was Strobel's device, and the best device he could furtively insert, without notice, during the trial was Holmes' Fig. 8. These are the specific parts of the prior art which appellee has elected, surreptitiously or not, to utilize in the presentation of his case.

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For the reasons set forth above and in appellant's brief, it is submitted that Finding of Fact No. 6 is in error.

FINDING OF FACT NO. 7

Appellee states (Ae.24) that appellant "at page 39" alleges no error in this Finding. Appellee's reference apparently is in error, for at page 39 appellant does not discuss the Findings of Fact. It should be mentioned that appellant submits that Finding of Fact No. 7 conflicts with the Opinion of the trial court, for in the Opinion the trial court held the claims unpatentable over Holmes in view of Strobel, and made no reference to Shanklin.

Other allegations of appellee will be discussed under Finding No. 11.

FINDING OF FACT NO. 8

This Finding involved the allegation of the Patent Office's Board of Appeals, on the last page of the last action (denial of petition for reconsideration) to the effect that "we are unable to determine . . how many manual switching and adjusting operations are necessary to make these (phase) comparisons." This allegation was raised at the instant it became impossible for the appellant to reply to it, for it was raised when the Appeal Board rejected the last possible administrative action open to appellant, where the only possible remaining step was to take court action.

Appellant's patent application had been filed on 18 November

1948, and the last action of the Patent Office, in which the above-quoted statement was made, took place on 25 April 1955. In all the many intervening years that the application was actively prosecuted, there was much correspondence, and a number of conversations between the appellant and the Patent Office. During all this time the Patent Office showed that it had a clear grasp of appellant's invention, and not a single comment, hint, or suggestion was made that the disclosure was inadequate or that the Patent Office really didn't understand the invention. The above circumstances suggest strongly that the obtuseness which suddenly developed in the Patent Office at the very end of the prosecution of the case therein was artificial, and was designed purely as a legal maneuver.

Appellee contends (Ae.24) that the above obtuseness concerning the operation of appellant's phase comparison system was preceded by a comment of the examiner, who stated in the final action: "Applicant's own system would undoubtedly require some adjustment." The examiner's remark has been quoted out of context, and referred to a completely different subject. The examiner's complete statement is given on p. 21 of appellee's brief, and refers to the fact that when the reference stations are set up, a zeroing adjustment must be made to correct for phase shifts in the system. This fact was set forth with clarity in appellant's specification (Ae.A.8a, 1st par.). It is mentioned elsewhere in the specification, for example at p. 8 thereof, where appellant stated,

> ". . . and from this phase comparison is obtained the difference between the distance from C to D and the distance from C to E, a correction being made for the constant phase shift introduced in the equipment and by the transmission from E to D."

Several methods of making this zero adjustment are set forth in the specification, one being at Ae.A.11a, lines 9-16. It is repeated that this is a zeroing adjustment, and is not repeated when the apparatus is in use. It in no way prevents continuous and automatic and simultaneous phase indications and position determinations.

Appellee argues (Ae.25) that no supplementary evidence bearing on the above points was introduced at the trial. Appellant points out that his specification is very clear and specific, and was even paraphrased by the examiner in the excerpt quoted by appellee on p. 21 of his brief.

The whole history of the case in the Patent Office, and the clear evidence provided by the specification, indicate that Finding of Fact No. 8 is in error.

Appellee argues that the basic point is not whether the Patent Office was correct. That might possibly be true (although it is in conflict with the assertion of the Patent Office that its actions and findings muct be presumed correct), but the basic question is: What inevitable conclusion follows from (a) the actions of the Patent Office, and (b) the uncontested disclosure in the specification? The fact that the appellant disclosed a completely automatic system, and the fact that the Patent Office so understood it during all the years the case was prosecuted stand as clear evidence not only that such a system was disclosed, but also that there was no question in the Patent Office that such a system had been fully disclosed, until the last page of the last action, to which appellant was not permitted to reply.

Appellee alleges (Ae.26) that after the above-mentioned objection to clarity of disclosure was made in the rejection of appellant's Petition for Reconsideration, appellant was entitled to reopen prosecution in the Patent Office and thus reply to this new ground of rejection. This is not correct, for the new ground was raised, not in the original action by the Board of Appeals (as appellee contends), but in the rejection of the Petition for Reconsideration (Ae.A.45a). This new contention was not used as a basis for rejecting any claim and hence the appellant could not ask for further consideration by the Patent Office under the terms of 35 U.S.C. 132, and Patent Office Rule 196.

FINDINGS OF FACT NOS. 9 AND 10

These Findings of Fact relate to rejection of the claims over a combination of the Holmes and Strobel inventions. The fact that no conceivable combination of the Holmes and Strobel inventions can be used to duplicate appellant's invention, and the fact that appellant's claims do not read on such a combination, have both been previously demonstrated.

Appellee's allegations (Ae.26-27) concerning the Holmes and Strobel inventions have already been shown to be incorrect.

Appellee argues that appellant's specific phase comparison means is not critical, since it is set forth in some claims and "not set forth in other claims". Appellee does not seem to realize that the claims cover a navigation system; not a phase comparator. All claims set forth a navigation system which can be constructed from the elements described by appellant, and which cannot be constructed from any combination of any or all of the elements set forth in the reference patents. The claims all set forth with clarity the patentable distinctions between appellant's system and any system which may be constructed from the references.

Appellee contends that he finds contradiction between appellant's assertion, in his brief, that the invention here at issue "is the heart of the Bomb Director System Mark 6, of the U. S. Navy" and appellant's testimony at the trial that he did not know what the Government had done with his invention after this had been delivered to the Government. The fact that Bomb Director System Mark 6 was invented and developed by the appellant, and the fact that the JAINCO system (the present invention) is a part of that system, are a matter of public record, for much testimony on this point was given by Government witnesses in _U_. _S_. _v_.

Jacobs, __ Fed. Supp. __, 239 F.2d 459, cert. denied 353 U.S. 904. This case originated as Civil Action No. 7459 in the U. S. District Court for the District of Maryland. In his Opinion of 1 December 1955, Chief Judge Thomsen said of the appellant (in describing how the bombing system work was started in 1949),

> "He had invented the JAINCO Navigation System and both he and the Government were interested in seeing some of the principles that he had used there and which he had worked out and was working out in his head in his shop used for the purpose of developing a bombing system."

Later in the same Opinion Judge Thomsen identified the bombing system that resulted from appellant's work as the Mark 6 System. The Bomb Director System Mark 6 was classified, and the presentation of enough information concerning this system in open court to permit a dispute involving it to be resolved, without disclosing classified information, posed some difficult problems. These problems were, however, solved to the satisfaction of all concerned. Thus, in his Final Opinion of 14 December 1955 Chief Judge Thomsen stated,

> "Fortunately, in this case, we have not been forced into the problems set out in the United States versus Reynolds, because both sides have been able to present their contentions without having to raise the questions of privilege since both parties have very wisely and properly agreed that classified material might be presented with such deletions that may protect the rights of the United States as a whole as well as the rights of the United States as a party to the case and the defendant party to the case."

Thus, the information set forth in appellant's brief was a matter of public record, and was material whose disclosure had been found not to jeopardize the national interest.

The question that was raised by the Court during the trial of the case at bar went into the question of where the Government was using this equipment. The appellant thereupon advised the Court that he did not have access to such information, and that such information was probably classified. The appellant also advised the Court that the equipment in which JAINCO was used is classified.

Appellant believes that there has been no inconsistency in the information given the district court and this Court, and further believes that all disclosure of information was handled in a way which completely protected the interests of the United States.

If evidence concerning the novelty and importance of appellant's invention is desired, it can be obtained from the transcript of the above-mentioned case, for Government engineers and experts testified at length on these points. With reference to the Mark 6 system (of which the JAINCO System was the heart), the Senate Armed Services Committee reported (in Senate Document No. 152, p. 28, 83rd Congress, 2nd Session), "The committee was deeply impressed with the significance of the project and the Navy Department has acknowledged its importance." It added, "All the parties agree on the importance of the project to the national defense. After a careful review of the facts, the committee concurs." This report was one of the Government's exhibits in the U. S. v. Jacobs case, supra.

In his brief, appellant pointed out that the basis of the Patent Office rejection of his claims was that the Patent Office alleged that the instant invention was a combination of old elements. Appellant denied vigorously that it was such a combination, and further pointed out that even if it were a combination of old elements, the rejection would lack validity unless the elements were combined in an obvious way or some reference could be cited showing or suggesting how the combination of the elements could be effected.

Appellee still maintains (Ae.28) that only a combination of old elements is involved in the JAINCO system, and appellant still disputes this contention. None of the references discloses a system like appellant's, and the claims distinguish clearly over any reference or any conceivable combination of references.

Hence it is submitted that Findings of Fact Nos. 9 and 10 are in error.

FINDING OF FACT NO. 11

Appellant contends that Shanklin (Ae.A.79a-82a) discloses no apparatus for making phase comparisons automatically or simultaneously or continuously. Shanklin utilizes a single phase comparator (whose construction he does not reveal), which he switches back and forth from one modulation frequency to another whenever he desires to make a measurement. Appellee alleges (Ae.30) that Shanklin "discloses the broad concept of simultaneous indication of phase difference by multiplication of indicating phase meters." This is incorrect. Shanklin merely uses one (undisclosed) phase comparator in a two-station system (his Fig. 3) for determining one hyperboloid. To determine the position of a mobile station, he merely uses two of these systems, and thus his mobile station contains exactly twice as much equipment as shown in Fig. 3. Thus he specifically has two phase comparators, each of which must be switched in turn to the three modulation frequencies to get a position measurement. Thus six readings must be taken in sequence to obtain a position determination. If two operators are present in the mobile station, they can each take three of these readings, thereby reducing the time necessary for a position determination. This is specifically what Shanklin describes when he talks of simultaneous readings, at Ae.A.85a, col. 1, L. 16-19. Appellee's allegations to the contrary are untenable.

Appellee further argues that Shanklin's phase comparator is automatic, although he admits it has to be switched manually from one frequency to another. His argument is based on the fact that Shanklin indicates he proposes to use an indicating meter (of undisclosed construction or character) for phase comparison. Appellee argues that if Shanklin has an indicating meter, and the meter is used at only a single modulation frequency, it is "automatic". In this way appellee seeks to argue that Shanklin can be cited as a reference against claims 33 and 37 which specify "automatically comparing the phases of the modulations of the various received carrier waves." In reply appellant points out Shanklin only discloses he proposes to utilize "a phase meter". It cannot be argued that this phrase discloses anything or that Shanklin has invented any type of phase comparator.

Similarly if a patent for a rocket launcher made reference to the fact that it could be used with an atomic-powered rocket, the patent could not seriously be used as a reference against a patent application disclosing the means for constructing such a device.

Appellee further argues (Ae.30) that "the only material question is whether a comparator such as called for by the claims at bar was available at the time appellant made his development." Assuming, arguendo, that this is correct, does appellee seriously argue that Shanklin's casual reference to "a phase meter" of undisclosed construction is to be taken as evidence that Shanklin (or anyone else) had invented an automatic phase comparator?

Although Shanklin states that the modulation frequencies of his two ground stations must be synchronized "by reference to any standard frequency or by land lines" (Ae.A.81a, col. 1, L. 38-40), appellee contends that this really means synchronization by a radio link, as is done by appellant. Appellant argues that if Shanklin had intended to use radio means of synchronization, he would have said so. Appellee's continual insistence that his references had invented things that they did not disclose or even remotely suggest is conclusive evidence of the weakness of these references.

Appellee asserts (Ae.31) that "Appellant adduced no evidence of a new result, in the sense of the test for patentable combination of old elements. . .". However, even if no tests had been performed, "paper patents" are valid, as appellee himself has contended (Ae.28). In this case exhaustive tests showing that new results had been obtained were performed, and this fact is a matter of public record (see reference, supra, to the evidence by Navy experts in U. S. v. Jacobs, and the remarks, quoted supra, of the Senate Armed Services Committee.

Appellant submits that Finding of Fact No. 11 is clearly in error.

CONCLUSION

All the claims on appeal, it is submitted, define clearly the properties of appellant's invention over the prior art. That the appellant has invented something vitally new and important is not contested in appellee's conclusion, and this fact is supported by the findings of impartial investigators. The claims at bar are the result of many years of negotiation between appellee and appellant. Appellee has demonstrated no prior invention, nor any combination of prior inventions, which meet these claims. Accordingly, it is further submitted that the judgment appealed from was in error and should be reversed.

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